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22 MAY 1987

JAPAN REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

INFORMATION POLICIES, EXPENDITURES FOR FY 1987 DISCUSSED

Tokyo DENSHO KOGYO GEPPO in Japanese No 11, 1986 pp 2-11

[Article by Toshimasa Ito, Electronics Policy Division, Machinery and Information Industries Bureau, MITI]

[Excerpts] 2. Promotion of Integrated Software-Related Policy

The stable supply of high-quality software is essential to the realization of a highly information-oriented society. In reality, the demand for software is explosively increasing due to the rapid advance in the dependency on information and the fast dissemination of computers taking place in present society. The annual rate of growth in the demand for software currently stands at about 26 percent. On the other hand, information processing engineers who can be engaged in software development work are in chronic shortage, and the supply of new engineers is limited. The number of such information processing engineers increases at a rate of only 13 percent a year. At this rate, the gap between the supply and the demand for software engineers may expand to such an extent that there will be a software crisis in the future. Furthermore, whereas the ratio of software cost to the total information processing expenses keeps rising, the requirements of software quality such as reliability are extremely critical.

To cope with the situation described above, various projects including the Sigma project are going to be positively promoted by the Information-Technology Promotion Agency (IPA)--a nucleus organization for the promotion of software-related projects. In addition, the implementation of the taxation system for establishing reserves to guarantee the quality of computer programs, which is an indispensable system in promoting software generalization, will be continued.

(1) Projects of IPA

The software production industrialization system project (Sigma project), inaugurated in fiscal 1985 to achieve rapid enhancement of the productivity and reliability in software development, and other projects to be promoted by the IPA are listed below.

(a) Sigma system project

Fiscal investment and loan:

-Industrial investment; ¥3 billion (¥2.8 billion)

-Financing by the Japan Development Bank; ¥500 million (¥300 million)
(Figures in parentheses indicate the corresponding budget for fiscal 1986.)

(b) General-purpose program development and distribution promotion project

Fiscal investment and loan:

-Industrial investment; ¥2 billion (¥1.4 billion)

(c) Research and development of operation and management techniques for small- and medium-sized enterprises

Budget:

-Appropriation from the budget for IPA's undertakings; ¥180 million
(New project)

(d) IPA's general-account undertakings

Budget:

-¥1.39 billion (¥1.26 billion)

(2) Financing for upgrading information processing (by the Japan Development Bank)

This system was established to finance equipment investments (some non-equipment investments may be included) to be made to enhance software development automation, to encourage software development engineers, or to develop software for inter-enterprise communication systems. (The most preferential special interest rate is applied.)

Fiscal investment and loan: ¥2.5 billion (out of a total fund of ¥85 billion)

(3) Extention of the taxation system for reserves for guaranteeing the quality of computer programs

The imbalance between the supply and demand in the field of software presently constitutes one of the most cumbersome problems to be overcome to promote social informationalization. Promoting a generalized software in such a situation will result in reducing thesoftware-related workload on the society as a whole. Therefore, the promotion of a generalized software will serve as a very effective measure in quickly narrowing the gap between the supply and demand for software.

Whereas the developers of customized programs can be sure of recovering the cost of developing such programs, those who develop general-purpose programs are obliged to run fairly high risks in recovering their program development costs. Recovery depends on how the general-purpose programs they developed will sell.

If nothing is done, the high risks run by the developers of general-purpose programs will slow the promotion of software generalization. To avoid such an undesirable consequence, it is necessary to continue the implementation of the taxation system for establishing reserves to guarantee the quality of computer programs. This taxation system is most instrumental in promoting software generalization.

Hence, it has been decided to continue the implementation of two taxation measures; one to allow reserves for general-purpose program development and the other to permit reserves for guaranteeing program maintenance.

3. Data Base Preparation and Information Distribution Service Enhancement

Data bases, as well as hardware and software engineers, should constitute one of the pillars of support for the information-oriented society, so that preparing adequate data bases is a precondition for social informationalization. However, Japan is lagging far behind other advanced countries in availability of data bases. It is therefore of urgent necessity for this country to prepare adequate data bases.

Hence, various measures coordinated to promote the preparation of data bases in this country will be implemented. Such measures will include those aimed at promoting the building of data bases in private sectors, expediting public data base generation, nurturing information distributors, expanding the distribution of government-owned data to private sectors, and preparing a better environment for data base utilization.

Furthermore, a measure to support the creation of video software libraries which provide an important medium for information distribution will also be implemented.

(1) Promotion of the creation of important data bases

The planning and research work for the development of data bases to be built jointly by industrial, academic, and public organizations in such fields as advanced technologies (fine ceramics, new industrial materials, etc.), energies, and securities, and are to play important roles in promoting the development of an industrial society in this country, will be carried out.

Budget: Promotion of the creation of important data bases; ¥66 million (¥66 million)

(2) Promotion of the nurturing of general international data base distributors

Research into the social and technical needs and seeds required to enable data base distributors and producers to structure general international distributor systems and the desired forms of such business will be carried out along with research on the software for making data base search operations easier and more efficient.

Budget: Promotion of the nurturing of general international data base distributors; ¥8 million (New project)

(3) Data base and information distribution service-related research

Research on concrete measures to prepare and promote data base, information retrieval, and video and audio information distribution services will be conducted while taking into consideration the needs of both the service providers and recipients.

Budget: Data base and information distribution service-related research; ¥8 million (¥8 million)

(4) Creation of public data bases and expansion of government-owned data distribution to private sectors

The development of public data bases already underway will be continued. These data bases contain, for example, information on small and medium sized enterprises, technical information and patent information. The information contained in these data bases is necessary for continuing the promotion of the industrial and trade policies of this country. Access by private parties to such public data bases will be facilitated, and the distribution of government-owned data, e.g. various statistics stored on handy magnetic tapes, to private sectors will be expanded. Furthermore, appropriate conditions for the distribution of such government-owned data to private sectors will be arranged.

(5) Supporting data base building in private sectors

The Japan Development Bank will invest in corporations which are to build fundamental data base systems required for the future development of industrial and social activities in this country. It will also finance investments in equipment and nonequipment items for the creation of data base systems.

A taxation system for data base building promotion will be enforced to reduce the equipment investment burden on corporations building data bases and also to facilitate updating the data bases built by such corporations.

(a) Financing of data base building costs (by the Japan Development Bank)

Financing of equipment and nonequipment costs to be born by corporations engaged in information distribution services in building data bases (Special interest rate 4)

Fiscal investment and loan: Appropriation for the promotion of information processing and communication system dissemination; ¥7.5 billion (Out of a total fund of ¥85 billion)

(b) Investments in corporations to build fundamental data bases (by the Japan Development Bank)

Investments in corporations which engage in information distribution services and are to build fundamental data bases required for the development of industrial and social activities and communities.

Fiscal investment and loans: Appropriation for the promotion of information processing and communication system dissemination; ¥7.5 billion (Out of a total fund of ¥85 billion)

(c) Creation of taxation system for the promotion of data base building

-1 Taxation system for the promotion of data base building

Under this taxation system, corporations engaged in data base services are given an option between a 7-percent tax credit on or a 30-percent initial year special depreciation of the costs (periodical rents paid for leased equipment may be included) of computers, peripheral equipment, transmission equipment, or terminal equipment acquired to build data base systems.

-2 Reserves for data base updating

Once a data base system is built, the system operator is required to keep the data base up-to-date by properly updating its contents and adding new information. The costs of data base maintenance is generally a great burden on the data base system operators. To relieve the data base system operators in this regard, a system which allows them to reserve 40 percent of the proceeds from their data base services to prepare for data base updating will be created. The system will allow such reserves to be kept for 4 years to be then included in the gross revenue in 4-year uniform installments.

(6) Data base register compilation

The compilation under way of general data base register books based on various data base registers, which list the types, locations, and contents of different data bases, will be continued.

(7) Support the creation of a video software library (Investment or financing by the Japan Development Bank)

There is demand for video software libraries which offer, after taking proper copyright-related procedures, collections of video software--an important information distribution medium to be used to support highly information-oriented society--for general utilization.

Against such a backdrop, the Japan Development Bank will invest in corporations which are to create video software libraries and will also furnish funds to such corporations to cover their equipment and nonequipment costs encountered in building video software libraries. (Special interest rate 4)

Fiscal investment and loan: Appropriation for the promotion of information processing and communication system dissemination; ¥7.5 billion (Out of a total fund of ¥85 billion)

4. Securing System Interoperability and Promotion of System Standardization

Whereas the dissemination of communication networks continues to progress, inconvenience is being experienced due to the fact that a large variety of information handling equipment and systems introduced to the market are not compatible.

Hence, need is growing among computer users for compatibility in the different makes of computers.

Under such circumstances, the system standardization work based on the OSI (open systems interconnect) is making headway, but the computer manufacturers and users will both be required to tackle more positively the task of securing system compatibility in the future.

(1) Promotion of OSI [Open System Interconnection] by international collaboration

-1 Holding Japan-EC bilateral conferences to be attended by high-level officials and experts

-2 Promotion of the association among the POSI (Japan), SPAG (EC) and COS (U.S.) at the private sector level [expansions not provided]

(2) Promotion of the advance and flexible standardization of information-related techniques in accordance with JIS

Setting of the OSI standard based on the Japanese Industrial Standard (JIS) will be promoted taking into consideration the results of study made by the ISO (International Organization for Standardization).

(3) Research and development of interoperable data base systems

A variety of data bases accessible at present are not interconnectable; they are not arranged in any coordinated way. Users of different data bases are therefore required to operate different terminal equipment connected to different data bases. In addition, such data bases have a disadvantage that they can accommodate only data comprising characters or limited graphics. To facilitate future activities to be carried out in various fields of the society, it is essential to realize systems which will solve all the foregoing data base-related problems in one stroke and can be used as a foundation of a society that is highly information oriented.

Hence, in connection with the OSI:

-1 An OSI subset and a functional standard will be created.

-2 Model system evaluation will be made by experiments.

-3 Testing of OSI-based system interconnections will be conducted.

Furthermore, R&D work on distributed data base system techniques, multimedia techniques, and high-reliability techniques will be carried out.

Budget: R&D work on interoperable data base systems; ¥1.11 billion (¥830 million)

(4) Preparation for making OSI-based interconnection tests

Interconnection tests are being planned and prepared for by INTAP (inter-system information processing technique association).

5. Promotion of Industry Informationalization

Informationalization in the industrial fields has been leading the move for informationalization of the economic society of this country. From now on, it is necessary to promote informationalization beyond the boundaries of individual enterprises and industries by building inter-enterprise information networks.

In such a situation, appropriate taxation systems and fiscal investment measures will be implemented to facilitate the building of inter-enterprise information networks. In addition, utilization of the guidelines for inter-enterprise association will be attempted and the promotion of informationalization of the electric power industry and other individual industries will be continued.

Furthermore, in order to arrange a foundation for the development of information industry which is to support informationalization in this country, the implementation of the fiscal investment system for the

promotion of computer utilization and taxation system for reserves for losses caused by repurchase of computers will be continued.

The steps taken so far are based on the consideration that the industrial and social activities are largely dependent on information networks. These include setting of the computer system safety measure criteria, recognition of corporations implementing safety measures for computers used for information processing services, and setting of the system inspection criteria. To reinforce such steps, new taxation measures will be implemented.

Furthermore, office equipment integration will be promoted with a view to promoting office automation in the industrial fields.

(1) Creation of taxation system for the promotion of network-oriented social structuring

A new taxation system to allow corporations which acquire computers and peripheral equipment for use in an inter-enterprise network an option between a 7-percent tax credit on the cost (may be inclusive of rents) of acquisition of electronic computers and peripheral equipment for use in an inter-enterprise network system and a 30-percent initial-year special depreciation of such costs will be created. The creation of such a taxation system is aimed at promoting the structuring of inter-enterprise network systems to be the foundation for proceeding with social and household informationalization for the purposes of realizing a highly information-oriented society; such a society is expected to contribute toward upgrading and vitalizing the industrial structure of this country and enabling the people of this country to lead comfortable lives. Furthermore, it is also aimed at contributing toward expanding the domestic demand, which is now an important task to be tackled by this country.

(2) Creation of taxation system for the promotion of high-level online information processing

A new taxation system to allow corporations which engage in information processing services to play a central role in the expansion of inter-enterprise network systems an option between a 7-percent tax credit on the costs (may be inclusive of rents) of their acquisition of equipment (such as electronic computers, peripheral equipment, switching systems, and repeaters) needed to make high-level online information processing and a 30-percent initial-year special depreciation of such costs will be created.

(3) Extension of the taxation system for reserve funds to cover losses caused by repurchase of electronic computers

A computer rental system is greatly advantageous to users; because (1) it enables them to have a computer installed just by paying the initial rent, and (2) it allows users to update their equipment with more ease before the equipment becomes obsolete.

For computer manufacturers, on the other hand, such a computer rental system is difficult to practice; because (1) the revenues they can obtain by renting computers are small, and (2) a large initial investment is required to start the rental business.

It is for the above-stated reasons that computers are rented through the JECC (Japan Electronic Computer Company). The JECC purchase computers to be rented to users from computer manufacturers based on contracts which contain a redemption clause. Therefore, when rented computers are returned, the manufacturers inevitably suffer a redemption loss.

To assist the computer manufacturers in keeping their accounts healthy, the implementation of the taxation system for reserves for loss caused by repurchase of electronic computers will be continued.

(Reference information) Outline of the system

-1 Computer manufacturers are allowed to lay aside a reserve fund calculated by applying the rate determined based on the actual records of redemption losses. (System initiated in fiscal 1968)

-2 The reserve fund is to be kept for 4 years and then to be included in the gross revenue in 4-year uniform installments.

(4) Creation of a taxation system for the promotion of computer system safety measures

-1 A taxation system (for a national tax) will be created to allow an 18-percent special depreciation of the buildings and equipment (the rate is 9 percent for buildings) which are of the types specified in the computer system safety measure criteria and which meet certain requirements.

-2 For buildings and equipment meeting certain requirements, the property tax base will be reduced to four-fifths for a period of 3 years after acquisition.

(5) Financing for computer business promotion (by the Japan Development Bank)

The Japan Development Bank will finance the computer rental business conducted by the JECC. (Most preferential special interest)

Fiscal investment and loan: ¥68 billion (Out of a total fund of ¥85 billion)

(6) Financing for the promotion of information processing and communication system dissemination (by the Japan Development Bank)

The cost of acquiring equipment required in connection with the following types of systems which make up part of the foundation for the promotion of industry informationalization will be financed by the Japan Development

Bank: (1) inter-business office information processing systems, (2) information processing systems for information processing or distribution service business, (3) systems such as medical systems, transportation systems, and disaster prevention systems which are of a highly public nature, (4) so-called VAN's [value added networks] and information processing CATV [cable television] systems, (5) video text systems, and (6) information processing and communication systems instrumental in promoting community informationalization (for bringing about the so-called new-media communities).

The data base systems and the systems instrumental in promoting community informationalization that can be the objects of this financing system are separately described in greater detail.

Fiscal investment and loan: ¥7.5 billion (out of a total fund of ¥85 billion)

(7) Financing for upgrading information processing (introduced above)

(8) Financing for information equipment reliability enhancement (by the Japan Development Bank)

To realize a highly information-oriented society, it is essential to improve the reliability and performance of information handling equipment drastically as well as their parts and materials. The Japan Development Bank will finance investments to be made by the manufacturers of such information processing equipment to achieve higher equipment reliability.

Fiscal investment and loan: ¥13 billion (out of a total fund of ¥85 billion)

(9) Government guarantee for borrowing by IPA to finance its low-interest financing system

The government will stand guarantee for the IPA for its borrowings made to obtain funds to run its low-interest finance operations for corporations designing systems or developing programs for use in intraindustry or interbusiness shared information systems.

Fiscal investment and loan: ¥1.8 billion (¥1.5 billion)

(10) Financing for the promotion of office equipment integration (by the Japan Development Bank and the Hollakdo and Tohoku Development Corporation)

To promote knowledge enhancement in the future industrial structure and service intensification in the economic field, it is essential to improve intellectual productivity by making use of office automation equipment owned by enterprises.

For the above reason, the Japan Development Bank and the Hokkaido and Tohoku Development Corporation will newly finance enterprises requiring funds for integrating office automation equipment in a way meeting certain conditions such as securing interoperability.

Fiscal investment and loan: ¥4 billion (New system)

(11) Promotion of the informationalization of individual industries

The best way to accomplish informationalization in industry will be studied for individual industries, including the electric power industry, which has great importance in that they affect community informationalization and informationalization of other industries. The guidelines for associations will be compiled based on the law concerning the promotion of information processing.

6. Promotion of Information-Related Technology Development

To allow the economic society of this country to grow into a highly information-oriented society full of vitality and enable the diversified needs of the industries and society to be met, constant promotion of technical development is indispensable.

For the above reason, the following projects that are under way will be positively promoted in fiscal 1987, too: the fifth-generation computer research and development, the development of new functional devices such as bio devices, research and development of interoperable data base systems, research and development of high-speed computer systems for scientific computations, and research and development of advanced social systems.

Furthermore, positive utilization of the investmentand financing functions of the Fundamental Technology Research Promotion Center will be attempted. In addition, a taxation system will be created which allows corporations, which have invested in a project sponsored by the Center, to lay aside investment loss reserves.

(1) Fifth-generation computer research and development

Powerful promotion of the research and development work on the new-generation computer (fifth-generation computer) will be continued this fiscal year, too, so as to realize a computer which makes full use of innovative technologies such as artificial intelligence and high-level parallel processing by the early 1990's.

In the R&D in fiscal 1987, partial system design will be made to develop inference subsystems and knowledge data base subsystems.

Budget: ¥5.65 billion (¥5.49 billion)

(2) Research and development of high-speed computer system for scientific computations (large-scale project)

The research and development work on a high-speed computer system (super computer) which is capable of very high-speed computations and is suitable

for use in scientific computations such as processing image data received from meteorological satellites will be continued.

Budget: ¥3.07 billion (¥2.89 billion)

(3) Interoperable data base system research and development (large-scale project)

Budget: ¥1.11 billion (¥830 million)

(4) Bio-device research and development (part of the next generation industrial basic technology research and development)

Full-scale studies on the information processing functions of living creatures and R&D work on bioelectronic devices which incorporate high-level information processing functions observed in living creatures will be initiated.

Budget: ¥150 million (¥60 million)

(5) Research and development of medical examination support system

To raise the level of medical services and enhance medical service efficiency by promoting informationalization in the medical field, the research and development work on a consultation system capable of directly assisting doctors in medical examinations will be continued.

Budget: ¥210 million (¥100 million)

(6) Utilization of the Fundamental Technology Research Promotion Center

The Fundamental Technology Research Promotion Center is an integrated service organization established to support technical development by private enterprises. It furnishes funds that can be risked to corporations which conduct fundamental technology research and development and supports joint undertakings among the industrial, academic, and public circles so as to promote fundamental technology research in the private sector. It also invests in joint R&D enterprises, offers conditional no-interest funds, and exercises its good offices for inaugurating joint research work between national laboratories and private enterprises. The functions of the Fundamental Technology Research Promotion Center will be used to promote technological development in fiscal 1987, too.

In addition, a new taxation system will be created to prompt private enterprises to participate positively in projects invested in by the Fundamental Technology Research Promotion Center.

Fiscal investment and loan: Industrial investment and financing; ¥29 billion (¥20.5 billion)

Creation of a taxation system for reserves to compensate for losses from fundamental technology research investment

A new taxation system to allow enterprises which invest in R&D projects sponsored by the Fundamental Technology Research Promotion Center to lay aside reserves equal to 50 percent of their contribution to such projects will be created.

7. Promotion of Community Informationalization

To attempt the smooth realization of a highly information-oriented society, it is vital to promote nationwide informationalization in a balanced way while trying to eliminate differences in the degree of informationalization among different regions.

Therefore, the new-media community project aimed at promoting the development and dissemination of different types of information systems to meet the needs of communities will be positively promoted. At the same time, the construction and preparation of base facilities for community informationalization (new-media centers) will also be promoted.

(1) Promotion of new-media community project

Communities that introduce an information system designed after a model information system but in an advanced form will be designated "development regions" based on the new-media community project. In addition, a system providing the development regions with funds advanced by the Japan Development Bank will be created.

Furthermore, standard information system specifications will be worked out based on the model information systems installed in model regions, and standard data bases will be generated according to such standard system specifications. Such standard data bases will then be disseminated to other regions where needs for such data bases exist to promote regional informationalization further.

Budget: ¥5.2 billion (¥60 million)

Fiscal investment and loan: ¥7.5 billion (out of a total fund of ¥85 billion)

(2) Promotion of the building of community informationalization base facilities (new-media centers) based on the private sector vitality utilization law

To promote the building of informationalization base facilities (new-media centers) which are expected to play a key role in community informationalization and thereby contribute toward the development of regional industry and economy, a system enabling prime constructors of such facilities to obtain funds or loans from the Japan Development Bank will be created.

In addition, a taxation measure to allow enterprises which invest in corporations established to promote the building of such facilities to deduct 10 percent of their investment from their income will be implemented.

(a) Investment in and financing for new-media center building corporations (by the Japan Development Bank and the Hokkaido and Tohoku Development Corporation)

Fiscal investment and loan: Appropriation to be made out of a total fund of ¥14.4 billion (new budget)

(b) Expansion of taxation measures to promote the building of new-media centers

-1 Enterprises which invest in corporations established to build new-media centers will be allowed to deduct 10 percent of the amount of their investment from their income.

-2 The special depreciation rate will be raised from the present 13 percent to 20 percent.

-3 The community information management base facilities will also be included in the type of facilities, for which constructors are considered for preferential financing or taxation.

(3) Others

(a) Financing for community informationalization base preparation (by the Hokkaido and Tohoku Development Corporation)

Fiscal investment and loan: ¥2 billion (Out of a total fund of ¥135 billion)

(b) Financing for community informationalization promotion (by the Hokkaido and Tohoku Development Corporation)

Fiscal investment and loan: ¥2 billion (Out of a total fund of ¥135 billion)

(c) Financing for the promotion of community information processing and communication system dissemination (by the Japan Development Bank)

Fiscal investment and loan: ¥2.2 billion (Out of a total fund of 120 billion)

(d) Investment by the Fundamental Technology Research Promotion Center in corporations established to promote the new-media community project

Fiscal investment and loan: Appropriation to be made out of a total fund of ¥19.5 billion (appropriation out of a total fund of ¥14.8 billion)

8. Cooperation for Informationalization of Developing Countries

To promote international informationalization, positive cooperation will be extended to developing countries including those in the Pacific region.

(1) Cooperative research on mechanical translation systems for translations between Japanese and languages of neighboring countries

For the purposes of eliminating language barriers between Japan and its neighboring countries and thereby promoting technical and cultural exchanges with such countries to a greater extent, research on mechanical translation systems for translations between Japanese and languages such as Chinese, Thai, Malay, and Indonesian will be initiated in cooperation with the corresponding countries.

Budget: Appropriation from the budgets for cooperative research promotion support project and cooperative research project; ¥180 million (¥30 million)

(2) Promotion of undertakings of the international informationalization cooperation center

To promote informationalization of developing countries and contribute toward the development of the economy and industries of such countries, programs for training engineers who can play central roles in promoting informationalization will be carried out. At the same time, Japanese engineers will be sent to developing countries to assist informationalization in such countries.

Budget: Appropriation from the subsidies for technical cooperation undertakings; ¥240 million (¥240 million)

(3) Research on information and communication bases in ASEAN countries

The guidelines for creating industrial bases for utilization of high-level information and communication techniques in ASEAN countries will be compiled in cooperation with the governments of the respective countries. This will be done by analyzing the present condition of industrial bases for nurturing information and communication systems in such countries and grasping the role of the information and communication industries as well as the need for high-level information and communication systems in the national economies of such countries.

Budget: Integrated development planning and research; appropriation out of a total fund of ¥90 million (¥30 million)

9. Construction of Informationalized Futuristic Cities

From the perspective of promoting the materialization of a highly information-oriented society and expanding the domestic demand, it is essential for this country to accelerate investments for social, industrial, and

household informationalization. Based on such recognition, advanced information systems which are expected to be introduced for dissemination in the 21st century will be installed in designated fields of some model cities and network systems ideal for promoting integrated informationalization covering different fields will be constructed with an aim of using such network systems to trigger the diffusion of information systems.

(General description)

-1 Futuristic cities in which highly functional business districts and comfortable living areas are pleasantly merged so that city residents can find places of work near their homes will be constructed.

-2 Building an information infrastructure to support the implementation of high-level information services will be promoted, for example, by configuring local area network systems utilizing optical fibers or constructing information centers which will undertake community information management, wide-area value added network system operation, etc.

-3 Advanced information application systems will be introduced to produce informationalization-related demand; for example, demands for the enhancement of social functions, the nurturing of information industry (new-media business), and the upgrading of existing industries.

-4 To cope with the internationalization of the business world, international business zones and hotels will be constructed to support advancement of foreign enterprises into Japan and heliports will be constructed to secure transportation from airports.

-5 The introduction of high-technology model systems other than those in the information-related fields; for example, new energy supply systems and high-speed distribution systems will also be considered.

Budget: Measures for promoting the introduction of new mechanical information systems for social development; ¥100 million (New budget)

° Financing for corporations which construct information systems in the areas designated for construction of information-oriented futuristic cities (by the Japan Development Bank)

Fiscal investment and loan: ¥200 million (New financing)

° Financing for the promotion of information processing and communication system dissemination (by the Japan Development Bank)

Fiscal investment and loan: ¥7.5 billion (Out of a total fund of ¥85 billion)

° Financing for the promotion of community informationalization (by the Hokkaido and Tohoku Development Corporation)

Fiscal investment and loan: ¥2 billion (Out of a total fund of ¥135 billion)

° Financing for the promotion of office equipment integration (by the Japan Development Bank and the Hokkaido and Tohoku Development Corporation)

Fiscal investment and loan: ¥4 billion (New financing)

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SETTLEMENT OF SEMICONDUCTOR NEGOTIATIONS WITH U.S. DESCRIBED

Tokyo DENSHI KOGYO GEPPO in Japanese No 9, 1986 pp 2-7

[Article by Tetsushi Mochinaga, Industrial Electronics Division, Machinery and Information Industries Bureau, MITI: "Settlement of U.S.-Japan Semiconductor Negotiations--Contents of Agreement and Prospects"]

[Text] Beginning with the worldwide semiconductor recession in 1985 and in response to the petition by the U.S. Semiconductor Industry Association (SIA) based on Section 301 of the U.S. Trade Act (retaliation against unfair trade practices by another party's government) and to the petition of "antidumping" by the U.S. major makers against the export of "memory" products by Japanese makers, several rounds of U.S.-Japanese negotiations were conducted since August last year. An agreement was reached on 30 July on the market "access" problem and the price problem. With regard to this, I now describe the background, history, and results.

1. Background of Problem

(1) U.S. Semiconductor Recession

The U.S. semiconductor industry experienced a sharp decline in the number of orders received because of the overheating of the market beginning in 1983 completely changed the situation by the autumn of 1984 and the demand for office automation (OA) equipment unexpectedly did not move upward. The BB ratio (a ratio of the amount of orders received against the amount of shipment) to indicate the demand and supply "balance" of the U.S. semiconductor market fell below 1 in September 1984 and remained sluggish throughout 1985. In particular, up to the beginning of the autumn of 1984, U.S. computer makers are said to have placed double and triple orders to meet the shortage of IC products. Thus, the production structure of each semiconductor maker was strengthened, so the shipment of products based on such orders increased toward the end of the year. However, the fact that the demand for equipment cooled off and cancellations to semiconductor makers began all at once intensified the sense of stagnation. Concretely speaking, a severe situation with an unprecedented deterioration of profit, layoffs, and decreased production continued.

Table 1. Ratio of Orders Received/Shipment (B/B ratio) of the U.S. Semiconductor Market
Source: WSTS (World Semiconductor Trade Statistics)

Year / Month	1984 Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
B/B ratio	1.61	1.49	1.34	1.32	1.27	1.20	1.12	1.02	0.90	0.76	0.68	0.64
Year / Month	1985 Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
B/B ratio	0.65	0.73	0.78	0.79	0.76	0.75	0.74	0.74	0.75	0.81	0.89	0.98

Table 2. "Layoff" Situation of Major U.S. IC Makers

Year	Month	Name of firm	Scale
1985	January	TI	¥2,000
		Zilog	400
	February	Intel	900
		Micron Technology	650
	March	Mostech	600
		NS	400
	May	Signetics	1,200
		Mostech	2,000
		Fairchild	1,200
	June	NS	1,300
	September	Motorola	5,000
	October	Motorola	900
	November	NS	500
1986	January	Intel	700

Table 3. Outline of Settlement of Accounts of Major U.S. IC Makers
(Unit: $1 million)

	TI		Motorola		Intel		AMD	
	1984	1985	1984	1985	1984	1985	1984	1985
Sales	5,741 (2,740)	4,924 (2,041)	5,534 (2,240)	5,443 (1,728)	1,629	1,364	922	623
Business loss and profit	525 (N.A)	Δ27 (N.A.)	N.A. (N.A.)	N.A. (N.A.)	250	Δ60	206	Δ45
Pretax loss and profit	486 (516)	Δ115 (Δ61)	466 (373)	45 (Δ38)	298	Δ5	208	Δ49

Note: Figures in ( ) are for Semiconductor Division

Table 4. World Market of U.S.-, Japanese-, and European-Affiliated Semiconductor Enterprises

(percent)

	1978	1984
U.S.-affiliated enterprises	65.3	55.7
Japanese-affiliated enterprises	25.7	36.8
European-affiliated enterprises	9.0	7.5

Source: Electronic Industries Association of Japan (EIAJ) (estimate)

(2) Deterioration of Competitive Strength of U.S. Semiconductor Enterprises

U.S. enterprises have a sense of crisis because the share the U.S.-affiliated enterprises in the world semiconductor market is on a down trend. In particular, U.S. enterprises are losing a foothold for the future in the memory field which is the leading semiconductor technology and which demands high-level sophisticated technology. In contrast, Japanese enterprise is increasing its world market share and is on an upward trend. It is overwhelming the United States in the memory field in particular. For example, in 1985 it held a 90-percent share of the 256K dynamic RAM (DRAM), a representative and advanced memory product.

2. History of Problem

(1) Up to the Petition Based on Section 301 of the Trade Act

Under the situation mentioned in the preceding paragraph, the fire of the friction first broke out in the U.S. Congress. On 20 March 1985 at the Joint House and Senate Economic Committee, the SIA submitted a report entitled "The Market Barrier of Japan in the Microelectronics Field and Its Influence on the United States." The SIA also criticized Japan, saying "the reason the share of U.S. makers in Japan does not increase is the existence of import barriers. If the Japanese market is opened, the share of the U.S. products would probably increase to 30 percent to 53 percent." At the same time, it onesidedly blamed Japanese enterprise stating that "the excessive production capability of the world semiconductor industry is caused by the dominance of capital costs in Japan."

After that, criticism of the Japanese market surged rapidly. In April, the U.S. Congress passed by an overwhelming majority a resolution for economic reprisal against Japan on the ground of the closed nature of the Japanese market. It became a situation in which demands for countermeasures and censure of Japan on the trade aspects cropped up one after the other.

In such a manner, the unprecedented upsurge of trade protectionism appeared rooted in the background of the delay in structural adjustment which can be seen in the large imbalance of the ordinary income and expenditures, and high-level unemployment. The free trade structure began to shake greatly.

In contrast, Japan has decided to promote measures to improve further access to the market by working out an "action program." The minister of international trade and industry also requested representatives of major enterprises in the export business world, the distribution business world, and representatives of business groups to expand the import of products. However, in spite of these measures, the expansion of the surplus in trade payments did not stop, and the problem in connection with semiconductors has been amplified into a "macro" imbalance problem between the United States and Japan. It has come to be taken up as a symbolic problem in the trade issue.

(2) Petition Based on Section 301 of the Trade Act

On 14 June 1985, the SIA filed a petition based on Section 301 of the Trade Act of 1974 (a countermeasure against unfair trade policy and practices of the other party's government) with the United States Trade Representative (USTR) on the ground that "Japan's semiconductor industry made an excessive facilities investment based on the background of the closed market structure in Japan originating in the past international trade policy of the Government of Japan and is inflicting damage to the U.S. industry by low price exports. In response to this, the USTR accepted the petition of the SIA on 11 July and decided that it would begin an official investigation. The outline of the petition by the SIA based on Section 301 is as follows:

a. Basis of Petition

(a) Even after the liberalization in 1975, U.S. products gained nothing but "marginal participation" in the Japanese market because of the structural closed nature of the Japanese market. The share of the U.S. products in the Japanese market has not improved at all since the liberalization.

(b) The structural closed nature of the Japanese market is caused by the subsidies and the countermeasures against liberalization taken by the Government of Japan.

(c) The Japanese semiconductor makers achieved a stable demand in a closed market, promoted the expansion of facility investment, initiated an offensive in exports at a low cost, and eroded the position of the U.S. semiconductor industry in the world market.

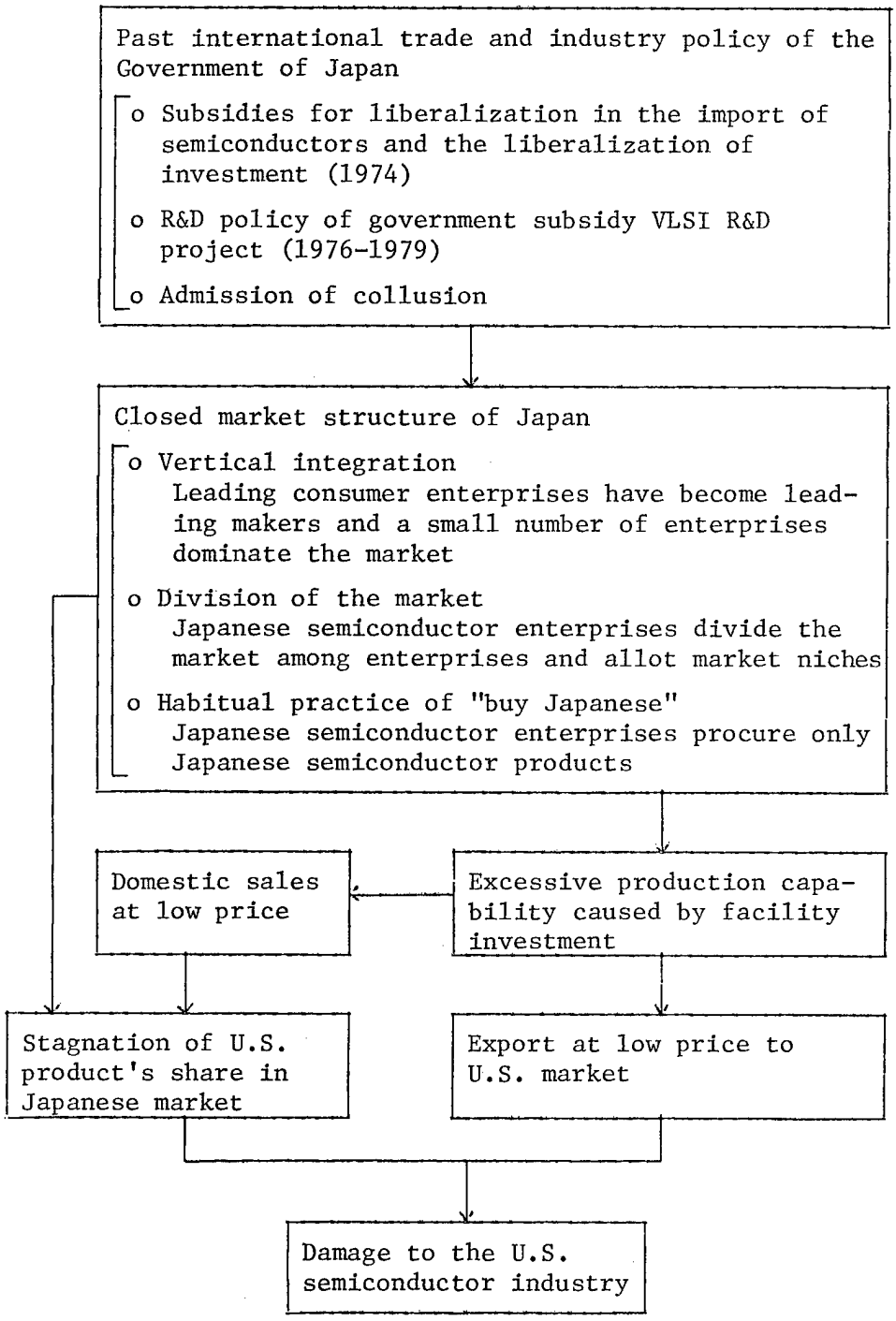
(d) The Government of Japan produced the structural closed nature of the Japanese market, and leaving this closed nature as it is unfair and unreasonable, and violates the interests of the United States.

b. Relief Measures To Be Taken

(a) Policy Goals Which President Ought To Adopt

(i) In viewof the competitive strength of the U.S. products in third country markets, to improve greatly the sale of the U.S. products in Japan within a short period of time. (To make the U.S. share in the Japanese market equal to Japan's share in the U.S. market by 1986)

Table 5. U.S. Side's View of the Semiconductor Market of Japan



(ii) To prevent potential "dumping" by Japan in the U.S. market

(b) Actions To Carry Out on Negotiations With the Government of Japan

(i) For the Government of Japan to encourage semiconductor makers and users in Japan to set goals and to increase their ratio of procurement of U.S.-made semiconductors

(ii) To prepare a "cost price model" with the cooperation of Japan and to set up a system to monitor Japanese dumping in the U.S. market

(iii) To improve and expand the existing "data collection system"

(iv) To reform the semiconductor market of Japan emphasizing the importance of competition on a long-term basis

(v) For the Fair Trade Commission to begin an investigation to determine whether Japanese enterprises violate the antitrust laws

(c) In the case no agreement is reached with the Government of Japan, measures for the President to take (while securing an appropriate supply to the "user" business world).

(i) The Department of Justice to investigate whether Japanese makers' actions to control competition is against the law

(ii) To file a petition against Japan based on Article 23 of General Agreement on Tariffs and Trade (GATT)

(iii) Unilaterally to prepare a "cost price model" and based on that, to invoke the Antidumping Law of the United States

(3) Japan's Refutation of Petition Based on Section 301

Against the petition by the SIA, the Japanese side insisted, in the view of the minister of international trade and industry and the opinion of the business world group, that the ground of the petition is inappropriate and unreasonable and is based on a misunderstanding of the facts as follows:

a. The Argument To Equalize Share Runs Counter to Free Trade

Market share is decided by various factors such as the demand structure of the market and the competitive strength of products. A government which sets up goals, including equalizing the share of the market, against the activity of the private enterprise will probably not only bring into question its practical effectiveness, but also hinder the free economic activity of the private sector.

b. Japanese Market, Along With U.S. Market, Most Open Markets in the World

The Japanese semiconductor market is free of a custom duty and has no non-tariff barriers such as a standards authentication system. It is a very competitive market.

c. Japanese enterprise facility investment activity has been conducted as the responsibility of each enterprise based on its medium- and long-range outlook. The investment to increase capacity is a reflection of the market situation, and "localized torrential downpour-like" exports from excessive facility investment has not been conducted in the way the United States insists. The rapid increase in exports in FY 1984 is caused by the expansion of demand in the United States.

d. Legal Eligibility of Petition

This petition insists that the Japanese market is closed structurally, because of the industrial policy of the Government of Japan prior to 1975, and, in addition, on account of forebearance to the closed nature of the market, the U.S. semiconductor industry has been harmed. Yet there is a question as to whether it is appropriate to insist that such a past policy of the government and forebearance by the government which ended more than 10 years ago constitute an unfair, unreasonable, and discriminatory policy.

(4) "Antidumping" Petition Problem

In response to the SIA petition based on Section 301, a consultation between governments is scheduled to begin in August. In addition to this action, a petition based on the Antidumping Law was filed on the ground that Japanese enterprises are engaged in sales at a price less than the fair price (in the principle of GATT, this means the domestic price in Japan, but in the example of this petition, domestic price of each product cuts into cost, so the construction price based on cost is adopted) in the United States as follows:

(Reference) With Regard to an Antidumping System

o Purpose

This is a system which each country is allowed to set up based on the GATT Antidumping Code. In case the industry of one country is damaged by imports at a price less than the fair price, a dumping custom duty can be imposed on the import from the country concerned.

o Procedures (stipulated in the law of the United States)

On receipt of a petition from the private sector or based on the initiation of an independent investigation by the Department of Commerce, the International Trade Commission (ITC) will investigate (each enterprise is requested to submit "cost data," etc.) as to the influence on the damage to the industry and the Department of Commerce as to the existence of dumping (whether or not sales at a price less than the fair price are conducted) and pass judgment. If both parties make a finding of guilty, the dumping custom duty will be imposed separately on each enterprise.

a. 64K DRAM Petition

Following the SIA's petition based on Section 301 on 14 June, Micron Co. (a firm not affiliated with SIA) brought action against seven Japanese enterprises on 21 June. With regard to this, in April 1986 the Department of Commerce made a determination of guilty and in June the ITC made the same decision. The "dumping margin" was 11.87 percent to 35.34 percent.

b. EPROM Action

In spite of the SIA petition, on 14 June, based on Section 301, the conversations between the two governments did not develop at all. (The first consultation between the governments was held in August and the second one in September, but no substantial development occurred.) Probably because of this, the three U.S. semiconductor enterprises (Intel Corp., National Semiconductor, and AMD), the mainstream group of the SIA, filed a petition against the eight Japanese enterprises. In November, the ITC made a provisional decision that unfair trade practices had occurred, and this year the Department of Commerce made the same provisional decision. On 30 July, as a result of the price agreement concluded between the Department of Commerce and the Japanese enterprises, the "dumping" investigation was suspended.

(Reference) With Regard to the Promise on Price

The promise on price is also authorized in the GATT Antidumping Code. This is a process by which the dumping investigation is suspended by means of making a promise between the Department of Commerce and producers or exporters to revise the price to eliminate the "dumping margin."

C. "Self-Initiation" of 256K and Over DRAM

With regard to this item, unlike the ordinary antidumping petition, an antidumping investigation began based on the initiation of an independent investigation by the Department of Commerce itself, not on a petition from private enterprise. Such initiations of an independent investigation by the Department of Commerce were extremely rare, made only two or three times in the past under the "trigger price" system in iron and steel. However, with regard to the fact that the Department of Commerce made bold to take such a measure, there was some conjecture as to probable impatience on the part of the Department of Commerce which was not the principal party concerned in the semiconductor negotiations at that time (December last year).

3. History of Negotiations

In response to this problem, the first U.S.-Japan semiconductor consultation was held on 24 August last year and the consultations, including consultation by specialists, have been held since then.

At the beginning, the Japanse side insisted that the petition by the SIA based on Section 301 was unfair and unreasonable based on the misunderstanding of the facts and developed a concrete refutation with regard to the contents of SIA's petition.

However, from the viewpoint that it is necessary to promote sound development of the semiconductor industry as soon as possible under both fair trade and free trade, the Japanese side decided to promote consultations with the U.S. side with regard to the concrete measures while reserving the stance of the Japanese side mentioned above.

In this situation, on 28 May this year, at the meeting between (then) Minister of MITI Watanabe, (then) Vice Minister for International Affairs of MITI Wakasugi, and U.S. Trade Representative Yeutter and Deputy U.S. Trade Representative Smith, an understanding was reached with regard to the basic frame for solving comprehensively the problem of "access" to the Japanese market and the price progress in these consultations, with regard to the EPROM and the 256K and over DRAM, on which the antidumping procedures were in progress, the initial signing for the promise on price to suspend the procedure was completed on 30 June and 2 July. The situation began to advance toward a final conclusion. In addition, to handle the remaining problem, MITI Vice Minister for International Affairs Kuroda, et al., visited the United States and held consultations with the USTR and the Department of Commerce. As a result, at the same time as the conclusion on 30 July and 1 August of the promise on the price in connection with the EPROM and the 256K and over DRAM, the problem was virtually solved on 30 July, and a letter is scheduled to be exchanged between Japanese Ambassador to the United States Matsunaga and U.S. Trade Representative Yeutter on 2 September.

4. Outline of Agreement

(1) Market "Access" Problem

a. The two Governments of the United States and Japan desire to expand free trade in the semiconductor field based on market principles and the competitive strength of each country's industry.

The Government of Japan will encourage domestic semiconductor makers to strengthen sales efforts.

b. The two governments expect a smooth expansion of "access" of foreign-made semiconductors to the Japanese market.

c. The Government of Japan will take the following actions. The Government of the United States also will support the actions as much as possible.

(a) To set up an organization to engage in sales support and quality evaluation of foreign-made semiconductors and to promote the exchange of researchers

(b) To promote long-term cooperation between Japanese users and foreign makers

d. The two governments will practice self-control on measures which lead to surplus semiconductor production capacity.

(2) Price (Prevention of "Dumping") Problem

a. Suspension of Existing "Dumping" Investigation

Suspension of "dumping" investigation on the EPROM and the 256K and over DRAM on the premise that the "suspension agreement" between the Department of Commerce and the Japanese enterprise will take effect.

b. Measures To Monitor the U.S. Market ("Monitoring")

(a) The Government of Japan will monitor cost and price with regard to the export of specific items in view of the importance of eliminating dumping.

(b) The items to be covered will be agreed upon between the United States and Japan from among the items, which are produced in large quantities and are on the increase in export and, in addition, are standard/general-purpose products or products with proof, or products suspected to have been sold at a price less than the fair price.

(c) The "cost" and export price data of items by individual enterprise will be submitted to MITI in accordance with procedures set by MITI. Japanese exporters will be encouraged to submit to MITI the data on sales price for third parties in the United States.

(d) The two Governments of the United States and Japan will hold consultations if requested after the United States presents information showing sales conducted by a Japanese enterprise at a price less than the fair price.

(e) Based on the result of the consultation, the Government of Japan will give guidance, if necessary, not to export or sell at a price less than the fair price.

(f) The Government of the United States reserves the right to initiate dumping investigations. A prior consultation will be held at the time of the initiation of the independent investigation by the administrative authority.

(g) At the time of the initiation of the dumping investigation, the semiconductor exporters of Japan are encouraged to make an early presentation of data.

c. Measures To Monitor Export to the Third Country Markets ("Monitoring")

The Government of Japan will monitor cost and export price, as the occasion may demand, with regard to export to third countries in view of the importance of eliminating dumping.

(3) General Rules

a. The conclusion of the "suspension agreement" on the EPROM and the 256K and over DRAM is the condition for the implementation of the agreement.

b. Consultations will be held, as the occasion may demand, to grasp the situation in which the measures were taken.

c. Revocation is possible if the basis of this agreement changes greatly.

d. No provision of this agreement will damage the interest of the third country or influence the rights and duties of the GATT.

e. Duration period is 5 years.

5. Future Implementation of an Agreement

As mentioned above, based on the agreement this time, the two governments agreed on a great number of things. In particular, the Government of Japan agreed to take practical actions, which are more numerous and diversified than we have seen before in the international trade negotiations, such as the encouragement of the semiconductor "users" in the market "access" problem, "monitoring" in the price problem. Thus the Government of Japan negotiated with the U.S. side, as the occasion demanded, with regard to the situation in which the agreement was implemented.

6. Significance of This Agreement

These semiconductor negotiations far exceeded the anticipated time limit of the settlement which was expected initially to be the end of the year. The final negotiations, the most difficult negotiations ever experienced, were conducted Saturdays and Sundays and by sitting up all night. The following reasons are cited:

a. There was not much significance in export restraint as a measure to solve ordinary international trade problem among other things, because the maker industry and the user industry have both been multinationalized.

b. In the United States there exists a user industry which has a voice, representing its interests, equal to or stronger than that of the maker industry.

c. This is an industry which is expected to grow in the future and in which the two countries are highly interested.

d. This problem could be handled as an individual problem in a symbolic manner under the "macro" economic problems in the situation in which Japan's trade surplus with the United States is greatly expanding.

In such a manner, an understanding was reached with regard to the complicated and difficult problem and positive evaluations were given by the Government of the United States beginning with President Reagan and by concerned people in Congress as well. This agreement needs to be steadily implemented not only by the government, but also by the semiconductor (maker and user) business worlds in Japan because the trend of this problem is being watched as a touchstone of future international trade problems.

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POWER COMPANY RESEARCH INSTITUTES EXAMINED

Hokuden Research Institute Activities

Tokyo ENERUGI FORAMU in Japanese Apr 86 pp 96-98

[Article by Toshihiko Nakamura, reporter for REPORTAGE ON RESEARCH INSTITUTES, No 1: "Challenges Technological Research With Frontier Spirit; Development of Heat Pumps Fit for Local Conditions and Utilization of Coal Ash: Technological Research Institute of Hokkaido Electric Power Co"]

[Text] On 4 January, on the occasion of the new year, Tomoo Takano, president of Hokkaido Electric Power Co., Inc., announced three important goals to all employees of his company:

1. Active promotion of development of power demand and cooperation in regional development.

2. Thoroughgoing implementation of cost reduction.

3. Putting new frontier activities into practice.

Hokkaido operates under special geographic and meterological conditions. The contribution to the prosperity of the local community by operating this electric power company with these conditions in mind leads to the prosperity of the company itself. Therefore, the goals set by Hokkaido Electric Power Co. (Hokuden) are to develop power demand and implement cost reduction. The method to be used to achieve these goals is to put the new frontier activities into practice.

The basic material industry which determines the character of the economy of Hokkaido has a great weight in the economic structure. The sluggish business of this industry, a large power user, is decreasing power demand. On the other hand, in the aspect of power supply, the difference in the quality of coal is causing the generating cost to rise, thus problems are mounting for the company. So, Hokuden is making all-out efforts to unite its workforce to break through these difficulties.

The Technological Research Institute of Hokuden assumes a mission to contribute to the new economy of Hokkaido by solving these difficult problems one by one from a technical side.

High Voltage Grounding Direction Indicator Is Fruit of Research

After about a 30 minute drive from Hokuden's head office centrally located in the city of Sapporo, while looking at the spectacular scene through the window, white buildings come in sight.

On the site of 39,670 m^2, six experimental buildings and laboratories are standing in a row in addition to the main building for the Technological Research Institute. Of the 68 workers there, 44 are researchers. The annual appropriation for its R&D expenditure totals about ¥500 million including expenses on equipment. The function of the institute is largely divided into three areas: "electric power," "chemical environment," and "civil engineering and construction," and specialized researchers are engaged in conscientious and steady research in each laboratory.

The Technological Research Institute, which was established in 1951, is enthusiastic about the study of subjects unique to the northern district, which is not taken up by other electric power companies, and also on measures for preventing various accidents.

One of the main results of research is represented by the high voltage grounding direction indicator developed independently by Hokuden. This detects ground faults in high voltage distribution lines and indicates the direction of the fault. So, it is widely evaluated by all parties concerned with electric power as well as other electric power companies as a high-performance "magic" instrument.

With respect to the countermeasures against the damage from snow, since electric wires are accidentally cut by the weight of piling snow in winter, research was carried out on the prevention of ice coating by using a blow-off type wind tunnel and, as a result, a special ring for preventing ice coating was devised. The sharp decrease in snow damage can be attributed to this.

Heat Pump Fit for Local Conditions Developed

In the experimental buildings behind the main building research on a detector for distribution line accidents and a detection method is being conducted in addition to the R&D of the technology concerning new energy, energy saving, and energy storing. What is given priority at present among other research themes is a heat pump system for both heating and cooling fit for a cold district.

The heat pump is of two types, air and earth. The use of the heat pump employing an atmospheric thermal source in the cold weather of Hokkaido has a problem in that the heating capacity is lowered as the outside temperature falls. Although its relative compactness is fit for use by general households, in order to serve this purpose it is particularly important for it to demonstrate expected heating efficiency during the coldest hours in the morning when it must be switched on.

Nevertheless, the operation of this type of heat pump under low temperatures could easily cause trouble. So, in order to have this heat pump spread to general households it is indispensable that this defect be rectified.

Under these circumstances, the Technological Research Institute began to improve the heat collecting section of the heat pump so that it can take in heat even in a cold region. The institute also started research on the technology capable of ensuring the smooth start of operation with heat stored in a paraffin-based heat storing material in the daytime when the temperature is high. In parallel, the institute installed on its site a heat pump for use in a cold region, which had been purchased on the market, and is collecting from it operating data during the winter. Additionally, the institute will conduct full-scale experiments on local climatic characteristics of the five main cities (Sapporo, Hakodate, Muroran, Asahikawa, and Kushiro) of Hokkaido. This survey seems to be drawing the attention of home electrical appliance manufacturers, who expect it to produce basic data useful for improving the heat pump utilizing an atmospheric thermal source.

The heat pump utilizing geotherm can be used in a large facility such as a building, since it is large in size. Although the research on this type of heat pump was begun in 1982, it is now being carried out under new themes.

By nature, the heat pump becomes more efficient the less the difference in temperature between the thermal source side and the radiating side. It is, therefore, more effective to take heat from beneath a flat ground in Hokkaido, where temperature is 10°C (5 m below the surface) throughout the year, but where the outside air is cold in winter.

The use of the geothermal heat pump is popular in foreign countries, particularly in Sweden. However, the existing heat pump of this system has the weaknesses that temperature is liable to fall due to poor thermal conductivity and that it is difficult to collect heat.

Therefore, the institute, along with Toda Construction Co., devised a vertical double heat collection pipe to be sunk into the earth, aiming to eliminate these defects through the improvement of the heat collection system of the heat pump. Heat taken through the sunken double pipe, in which an antifreezing solution circulates, is used through the exchange of heat with freon gas. This geothermal heat pump developed by Hokuden is expected to play a great role in the near future in developing power demand as a system for both heating and cooling, which is excellent in thermal efficiency.

However, the technology to remove geothermal energy by using the double pipe and antifreezing solution still leaves room for improvement. So, the institute will test 10 experimental machines installed in 10 cities by hiring monitors. While watching the results of the tests, the institute will conduct additional research on heat exchange, etc. The institute plans to put this heat pump to practical use before March 1988. In other areas of R&D of heat pumps, a system using a hydrogen storage alloy for heating and cooling, which can be called a future technology, is noted. Hydrogen is moved by

compressor between a pair of vessels (an alloy container) filled with an alloy compounded with misch metal and calcium. This alloy generates heat when absorbing hydrogen and the alloy that absorbed hydrogen, absorbs heat when heated and discharges hydrogen. The above system for heating and cooling utilizes the alloy's function of generating and absorbing heat.

The research on this system has been carried out jointly with Nippon Seiko K.K. since February of last year as part of power demand development program. The commercial operation of a spa exhaust heat recovery system started in January of this year at Kesui So of Jozan Kei, Minami-ku, Sapporo. This heating and cooling system using exhaust heat of a middle temperature of 40°C-70°C as a thermal source has the advantage of high efficiency, compared with the existing compression-type heat pumps and produces calories more than seven times the electric energy input. "It is wished to experiment with this system by using exhaust heat of a temperature as low as about 10°C" said Kunihiko Saito, director of the institute (the present director is Yukimori Matsuno).

Moreover, characteristic tests are being conducted on a floor-type heat storage heater using heat storage materials made in West Germany. This heater, which stores energy in advance as heat, and radiates heat as needed, not only contributes to increasing midnight power demand, but also further promotes load leveling. Therefore, it cannot be overlooked.

This electrical heat pump is superior to other heating and cooling systems (kerosene and gas) in terms of convenience, safety, and cleanliness. It will attract consumers' attention in the future if its thermal efficiency is raised and economical efficiency is improved in consideration of the climatic conditions of Hokkaido.

An environment experimental building, in which chemical environment tests are conducted, stands catercorner to the electric power experimental building on the other sideof the street. In this building the chemical analysis and measurement of fuel, service and waste water, air and various materials of the electric power facilities are conducted in addition to the research on the treatment and utilization of waste matter from the electric power plants. Additionally, unique research is conducted such as experiments on marine life including fish hatching and plant ecological experiments on strawberries, etc. by using plant environment experimental equipment.

In a marine life experimental room salmon hatchlings about 1 cm long are being bred in water tanks. It is said that they grow up to 15-20 cm in a year. This laboratory creates a different atmosphere from other facilities engaged in other research areas. By using these hatchlings, the laboratory is making study on how to reduce the intake of the young of fish, which occurs with the intake of water at electric power plants. Also, experiments are being done in the laboratory on the atmospheric environment by using plants.

Technological Research on Effective Utilization of Coal Ash Making Progress

The civil engineering and construction department consists of a civil engineering experimental building, hydrographic, and hydraulic experimental building,

and coast hydraulic experimental building. Because of the area of research--civil engineering and construction--the experimental facilities are large; the civil engineering experimental building is the largest of all, having a floor space of 1,195 m^2.

Not to speak of the hydraulic research on civil engineering structures (coasts and rivers), a seismic research on power generation facilities and research on the safety of the soil and foundation are being conducted in this department. What is drawing particular attention from among others is the research on the effective use of coal ash.

Coal ash produced by coal-fired thermal power plants of Hokuden totals more than 1.6 million tons a year. Tomato Atsuma Power Plant alone produces 1,000 tons of coal ash a day. "I wondered if coal ash could be used as a source of material. With the thought that if it could be and pay, then the generation cost could be held down, I have started the study on it," Kunihiko Saito described in detail how the idea of using coal ash came about. The use of coal ash is another research theme unique to Hokuden.

The technological research for manufacturing products from coal ash has been carried out by other electric power companies, too. For example, Kyushu Electric Power Co. is making artificial lightweight aggregates from coal ash and Electric Power Development Co. has been making fertilizer for more than 20 years.

However, if the effective use of coal ash results in boosting up the generating cost, there is nothing to be gained from it. In order that the utilization of coal ash can be really effective, the processing expenses should be lower than the disposing expenses incurred in transporting coal ash to the dumping ground, since there is a view that if the processing expenses are higher, the dumping of coal ash is more economical.

Disposing of coal ash costs Hokuden about ¥1,100 per ton, so they drew on their resources to develop a product of high utility value with a processing cost lower than this. As a result, a method of using coal ash as roadbed material effective in preventing the ground from freezing has been developed.

Hokuden segregates fresh coal ash, which just came out of the silos of the thermal power plants, from coal ash more than 1 year old. Coal ash has a special property called the Pozzolan reaction, which prompts its fine particles to bond together through the action of water on them and increases their strength. Aged ash shows this phenomenon and is fit for use in land development.

In an attempt to make coal ash, aged less than 1 year, usable in land development, the institute is conducting research on the acceleration of the Pozzolan reaction by mixing coal ash with lime and cement.

Furthermore, the institute is conducting research on coal ash utilization technology such as RCC, SAM, and ash column methods, which are adopted in constructing dams and solidifying foundations.

The ash column method, among others, is an epoch-making civil engineering method, which utilizes the special property of coal ash that its specific gravity is light. This method is to form a cylindrical solid (a column) in the soft ground by using a fiber bag permeable to water. The column is formed in this way: coal ash slurry containing additives such as cement and plaster is fed into the bag by pump while pushing aside surrounding soil, and then pressed and dried. This method enables the reduction of land subsidence and efficiently prevents the ground from sliding and floating at a low cost. The demand for coal ash is predicted to expand, so this ash column method deserves nationwide attention.

There is another "treasured article," of which the institute is proud. It is a desulfurizing agent made of coal ash. Since SOx, NOx, and soot are exhausted from coal-burning thermal power plants, various kinds of desulfurizing and denitrating devices and electrical dust collectors have been introduced as a means for environmental protection.

The institute is carrying out the research aimed at improving the economical efficiency and upgrading the performance of desulfurizing devices. The institute is conducting tests of a pilot plant of 1,000 Nm^3/h on the site of Ebetsu Power Plant jointly with the thermal power department and in the process of these tests a desulfurizing agent made of coal ash has been developed by the institute.

The desulfurizing device has two systems, dry and wet. The dry system is to convert SO_2 into sulfuric acid generally by making activated charcoal absorb and oxidize it and finally recover it as sulfur. Since flue gases can be treated as they are, this system has the advantage that there is no need to treat waste water. However, since the price of activated charcoal, an absorbent of SO_2, is high, it is earnestly desired that a cheaper one be developed.

Since this desulfurizing agent uses coal ash as the main raw material, it costs much less than activated charcoal. Its desulfurizing performance is superior to that of the existing SO_2 absorbents. It reacts on SO_2 quicker and is capable of reacting even on the core of a particle. Furthermore, it is a surprise that the desulfurizing agent made of coal ash is three times longer in useful life than activated charcoal and performs both functions of desulfurizing and denitrating at one time.

It was an established theory until now that desulfurizing agents do not react under the temperature below 350°C in desulfurizing and denitrating solids. With cooperation of scholars at Hokkaido University, the reaction could be successfully secured under the temperature of 130°C-150°C by curing solids with steam under atmospheric pressure. If this method could be put to practical use, it would become possible to carry out desulfurizing and denitrating at the chimney stage, so it would then create a sensation in every sector of the industry.

Toden Research Institute Activities

Tokyo ENERUGI FORAMU in Japanese Aug 86 pp 59-61

[Article by Toshihiko Nakamura, reporter for REPORTAGE ON RESEARCH INSTITUTES No 2: "Dynamic Research Activities Aimed at 'World Technology'; Leads in Research on Coal Gasification and Fuel Cells: Technological Development Division, Tokyo Electric Power Co."]

[Text] The popularity of Tokyo Electric Power Co. (Toden) is sharply rising among the university students of science and engineering. A survey of "popular enterprises" conducted by "Mainichi Communications" by polling 66,000 male university students expected to graduate next spring shows that Toden ranked 19th among the students of science and engineering. This represents the rise by 21 percent from 40th last year. This may be a natural result for such a large enterprise in Japan as Toden, but what factors contributed in bringing Toden to the top class in the engineering area, keeping up with popular enterprises specializing in information and communications such as Nippon Electric Co. and Fujitsu, Ltd.

Toden won sweeping popularity from young hopefuls who live in the future. Where did the bewitching power of its technological development activities, which was substantiated by this popularity, come from?

Frankly speaking, the reason for Toden's drastic rise in popularity is that it is challenging attractive themes of R&D. What has interested students is that it has been challenging the development of new future-oriented technologies such as fuel cells for some time. It is reported, in fact, that the number of students who wish to participate in the research on advanced technologies such as fuel cells and UHV transmission is drastically increasing recently. Managing director and manager of Technological Development Division Tsuneo Mitsui showed his keen enthusiasm by saying, "I wish to expand research activities qualitatively by calling in the best brains, including doctors."

It is said that students seeking employment lay stress on "dynamism," "stability," and "rewardfulness" in selecting enterprises. Since Toden had already been famed for its stability, and is now complemented with dynamism and rewardfulness, there is no wonder that it attracts students of engineering.

Technological Development Is Key to Management of Electric Utility

Toden drew up in June of last year a vision of the future titled "The Basic Direction of Management Toward the 21st Century." The company stressed in it the strengthening of the system for promoting technological development as one of the pillars of important measures for coping with such changes in environmental conditions surrounding the electric utility as the evolution of technological innovation. This is designed to reduce cost, improve service, and enhance the efficiency of management by actively tackling the development of application and future-oriented technologies, based on basic technologies to be developed, with the 21st century in perspective.

As a result of reorganization, a setup consisting of three research institutes and three departments has been created with the manager of Technological Development Division at the top (see figure). The "Technological Research Institute" conducts general technological research centering on basic research. The "Research Institute for Development" is in charge of R&D of large-scale projects such as coal gasification electric power generation and fuel cells. The "Nuclear Power Research Institute" conducts R&D of nuclear power technology including the new technology for nuclear fuel cycle. These three institutes form a trinity for carrying out research.

The number of research workers totals 270. The appropriation for R&D expenditure for 1986 amounts to ¥45.2 billion approximately, up a little over 10 percent from a year earlier. By the way, the R&D appropriation for 1985 was ¥39.6 billion.

An electric power company's stance toward technological development largely depends on how technological development is positioned in the operation of the company. The concrete research themes ranging over many areas have originated from the stance of this company.

"In order to demonstrate satisfactory adaptability to changes in the situation inside Japan and abroad and make a fresh advancement in the management of an electric power company, new technology is indispensable. General private enterprises cannot survive without producing new products. Although the electric power company is different from general private enterprises in the type of business, it still needs new technology in order to survive energy contests. The electric utility is subject to constant demands for safety, cleanliness, low cost, and convenience. The development of technology is indispensable to the management of electric utility in order to meet such demands," remarked Mr Mitsui.

Concerning Toden's positioning of technological development in Japan and the world, "Demands and expectations from the society toward our company are strong beyond expectation. We have been committed as a public utility corporation and a leading enterprise to satisfy technological demands as much as possible in the interest of general consumers, manufacturers, and vendors. Thus, it is important to contribute to the social and cultural development through technological development," he continued. "In the aspect of international relations, there is trade friction and the criticism that Japan has no basic technology. In order to be relieved from such a charge it is important to take action to contribute to the progress in science and technology in accordance with the national basic policy," he concluded, stressing his company's stance toward technological development.

This attitude toward technological development is reflected exactly in the company's long-term technological development project. This project consists of four themes: 1) research on energy supply technology concerning nuclear power and coal, aimed at ensuring the energy security and the best energy combination; 2) research on the overall promotion of energy supplying efficient fuel cells and all-electric houses, and the development of demand; 3) research on the automation of equipment and technology capable of

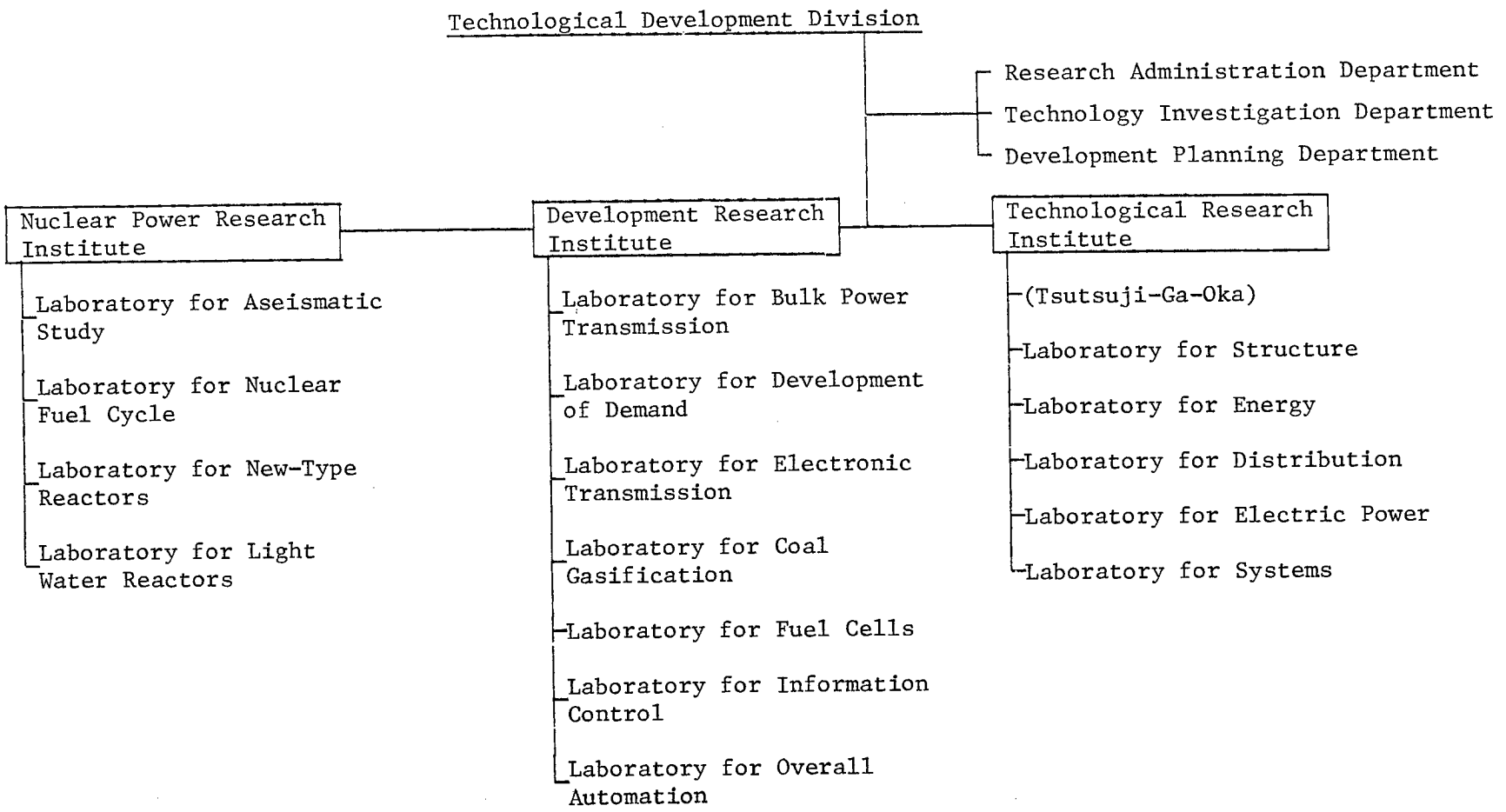

Figure. Organization Chart of Technological Development Division

urbanizing advanced information transmission system; 4) the research on across-the-board cost reductions.

The technological development activities in these four areas are being conducted under the themes individually set for three terms, short-term (1986-1990), medium-term (1991-1995), and long-term (1996 onward), with respective goals.

Research on Nuclear Power Holds Key To Supply Technology

What are positively taken up by Toden as research subjects from among many future energy technologies are new nuclear power technologies such as fast breeder reactors and laser uranium enrichment, and coal gasification composite power generation.

Fast breeder reactors use as fuel the plutonium recovered from the nuclear fuel spent by light-water reactors through reprocessing.

While light-water reactors can use only uranium 235, which constitutes only 1 percent of natural uranium, fast breeder reactors convert uranium 238, which makes up the remaining 99 percent, into plutonium inside the reactors and breed more fuel than is spent so they can contribute to the effective utilization of uranium resources. However, there are many technological problems to be solved in the development of fast breeder reactors.

This company is cooperating with the Electric Power Development Co. in R&D of a proving reactor following "Monju" (280,000 kw output), a prototype reactor. Regarding this proving reactor, the following research themes are presented: 1) to ensure the reliability of the system to shut down the reactor in case of emergency; 2) the verification of its capability to eliminate the intense heat generated in the reactor core through the natural cycle of sodium; 3) the designing of the plant by attaching importance to economical efficiency and the development of equipment and systems.

In the meantime, coal gasification composite power generation is expected to promote thermal efficiency, compared with the existing pulverized coal-fired thermal power generation. This is a new system combining a gasification furnace, gas purification device, and combined generating device of gas and steam turbines, and is superior in environment protection.

With respect to the coal gasification furnace, the company evaluated the spouted bed system furnace as the fittest. This furnace gasifies, at high temperature, pulverized coal fed into the furnace together with air or oxygen. So, the company participated in the cool water program of the United States and at the same time positively joined in the national project that started in this fiscal year. The cool water, a proving plant with the capacity of 120,000 kw, is operating smoothly, achieving a cumulative operation time of 8,500 hours and generating energy totaling 800 million kwh before March of this year, and provided valuable data concerning control. Before the practical use of the combined coal gasification power generation cost reductions must be achieved through the expansion of the capacity of the gasification furnace and

establishment of the technology for the high temperature gas turbine of the 1,300°C class, which introduces ceramics into the section of a high temperature, and development of the dry-type gas purification enabling the reducing of heat loss. The company is challenging such technological development with the cooperation of heavy electric machinery makers, basic material manufacturers, and universities.

With respect to the technologies concerning the promotion of the efficiency of energy supply and the development of power demand, the company produced excellent results in the technological development of fuel cells.

The fuel cell is an electric power generating system, which obtains electricity through the electrochemical reaction between hydrogen and oxygen. The fuel cell has the advantage of high power generating efficiency and is superior in protecting the environment. Furthermore, it has another merit in that it can be installed in scattered places within cities, since it is possible to design a more compact cell.

This company has succeeded in generating electric power for the first time in the world by a fuel cell at the proving plant (4,500 kw class) located on the site of Goi Thermal Power Plant resulting in the cumulative operation time of 2,423 hours and the total generated energy of 5.43 million kwh.

The commercialization of the fuel cell is imminent and the problems yet to be solved are said to be the improvement of reliability and the reduction of cost.

Toden has started the development of a compact fuel cell of the 200 kw class to conduct proving tests of a compact fuel cell on the site of the New Tokyo Thermal Power Plant with the aim of introducing a cogenerating system. This cell will be subject to experiments for 3 years on dual-purpose electricity and steam generation and operating reliability, and the tests for miniaturization and the improvement of economical efficiency. The present cogeneration entails environmental problems in regard to NOx and SOx, since it generates electricity and heat through the combustion of gas, kerosene, and heavy oil by gas turbines and engines, etc. So, it is much expected to introduce the fuel cell, which is superior in the preservation of environment, into the cogeneration system.

Apart from the above, Toden is buckling down to the R&D of a new storage battery--a sodium-sulfur battery. This battery is noted, because it may possibly replace the hydraulic power pump generator in the future as energy storing equipment that can be installed near consuming areas. Storing electricity is so helpful to the improvement of a load capacity that it can be one of the attractive research themes for the electric utility.

With respect to the future-oriented all-electric house, the newly developed high-output electric range for cooking Chinese food erased the image that the kitchen range is not fit for cooking.

In the development of a heat pump, the company succeeded through the concerted efforts with Hitachi, Ltd., in putting to practical use a unit-type ice heat

reserve air conditioning system uniting an ice heat reserve tank and a heat pump in one body.

Furthermore, the company is eager to develop an all-electric house where these single products are so organized as to operate organically in such functional areas as air conditioning, supplying hot water, and cooking.

A collection of equipment that represents the new technologies cultivated through research done so far, is displayed at (La Belle Vie-21), which opened in the spring of this year at Mitaka, Tokyo. Expectations of this company's capability to provide electricity with added value amid the energy competition are entertained.

Enthusiasm About Research on Electrical Energy Transmission Technology

As urbanization and information networking advance, the demand for the stable supply of high quality electricity becomes stronger. Also, as urbanization progresses, it becomes necessary to lay underground distribution lines to preserve the appearance of the streets and utilize space. The development of the technology capable of meeting such social needs is also indispensable.

By putting in its own technologies, the company is challenging the research on technologies concerning the laying of underground distribution lines, inner-cooled cables, a failure-free distribution method designed to upgrade the quality of electricity, a high-level information transmitting system to support information networking, and the synthetic automation of equipment.

UHV transmission lines and CV cables, among others, are drawing attention as the electric energy transmitting technologies of the 21st century.

Besides, Toden is making efforts in developing the robot technology for performing various operations. Thus it spares no effort in upgrading nuclear power generation, cost reductions, mechanization, and labor saving.

The electric power industry develops technology for its own use, but should at the same time develop it from consumers' standpoints in order to meet exactly their needs arising in this low growth era. This company, not limiting its research activities to its existing domains, from time to time carries out research on themes belonging to customers' domains. From this company's stance, its great enthusiasm for making a contribution to the world of the 21st century is noticed.

Hokuriku Research Institute

Tokyo ENERUGI FORAMU in Japanese Sep 86 pp 58-60

[Article by Toshihiko Nakamura, reporter for REPORTAGE ON RESEARCH INSTITUTES No 6: "Aims at Developing Technologies 'Useful to Local Community' Through Industry-University Cooperation; Research on Varied Utilization Methods of Coal Ash: Technological Research Institute of Hokuriku Electric Power Co."]

[Text] The high ratio of students who go on to schools of higher grade; the number of public libraries trebling the national average; and one of the highest ratios of households owning their own houses. The character of inhabitants of the Hokuriku districts consisting of three prefectures, Toyama, Ishikawa, and Fukui, all with this background, is known for "industry" and "integrity."

Hokuriku districts blessed with such inhabitants have many large rivers and so are well known for their abundant water resources. The Hokuriku districts are close to the three big economic blocs, Keihin, Hanshin, and Tokai, within 300 km. It can be said that the Hokuriku districts enjoying the three advantages of talent, rich water resources, and favorable geographic locations have the potential of further economic expansion. Hokuriku Electric Power Co. has a share in developing the regional economy, according to Yoshio Morimoto, president of the company. Let us look in at its Technological Research Institute supporting the company from the technical side.

The institute is about a 10-minute drive northward from the center of Toyama City where the company's head office is located. At the research facilities having towering magnificent peaks of the North Japan Alps in the background 56 research workers are working. The institute's appropriation for R&D expenditure amounting to about ¥2.9 billion including a share of expenses represents about 0.75 percent of the company's sales.

Since it was renamed as a research institute from the technical experiment station in 1959, the institute underwent frequent reorganization to ride the wave of technological innovation, and finally set up the present system consisting of nine assignments (see table).

The institute has until now created a number of new electric power technologies such as the automatic regulation-type centralized reactor to constantly compensate grounded current, the end detection-type broken line detection device useful in detecting disconnection accidents of distribution lines and the grounding point exploring device used for distribution lines capable of discovering grounding points with ease by using DC high voltage pulse voltage. The institute has produced valuable research results by giving technical solutions to the damage by thunderbolts, injuries from salt and snow damage. Such damage occurs in the districts of Hokuriku alone, so that other electric power companies do not carry out research on it.

Table. Organization Chart of Technological Research Institute

In charge of research administration	Planning of research programs; adjustment of budget; general control of research activities; administration of technical information and documentary records; business concerning invention; and miscellaneous affairs
In charge of electric power technology--generation and transformation of electrical energy	Investigation and study concerning maintenance of generating and transforming plants and metallic materials; investigation and study on high voltage phenomena by using an impulse-voltage generator; investigation and study on maintenance of transmission lines; and investigation and study on properties of lightning
In charge of electric power technology--distribution of electrical energy	Investigation and study on overall automation of distribution lines and countermeasures against higher harmonic
In charge of system technology	Investigation and study on stability of electric power system
In charge of electronic technology	Investigation and study concerning upgrading of reliability of communications equipment; putting optical fiber cables to practical use; and investigation and study on solar light power generation
In charge of thermal power and environment	Investigation and study concerning technology to analyze and measure composition of air and coal. Various chemical analyses and experiments
In charge of civil engineering technology	Experiments of proliferating warm waste water discharged from thermal and nuclear power plants, and hydraulic experiments of coast structures and civil engineering structures of hydraulic power plants
In charge of new energy technology	Investigation and study concerning geothermal and fuel cell power generation and other new energy
In charge of effective utilization technology of electricity	Investigation and study concerning effective utilization of electric power for buildings, households, plants and agricultural, and fisheries industry

Valuable Data Collected by LLS

The institute's 1986 research goals are: 1) the improvement of overall efficiency; 2) the effective use of electric power; 3) the promotion of electric source diversification; and 4) the technical cooperation with local industry.

The study on the improvement of overall efficiency includes items such as the modernization of measuring control, upgrading the reliability of supply and promotion of efficiency in construction and maintenance. The main research themes for the institute concern the installation of digital communications networks, the establishment of equipment diagnostic technology and a deep-buried earthing method in relation to the installation of substations. What is noticed as an up-to-date technology of its own is the prevention of damage by thunderbolts.

In Hokuriku districts thunder develops very often not only in summer season, but in winter as well. Since there are few regions in Japan which are struck by lightning in winter, it is an important task for Hokuriku Electric Power Co. to work out countermeasures against a lightning surge. Therefore, in 1978 the institute started an investigation into the actual conditions of thunderbolts in winter jointly with the Central Research Institute of Electric Power Industry.

The institute has succeeded in regular observation of the currents of lightning strokes at a tall chimney by using a device developed in 1980 and employing optical fiber and a computer, for the automatic recording of multiple lightning wave forms. Therefore, the institute started the observation of lignting in December 1984 by using a system for locating lightning (LLS) installed at Matto and Anamizu in Ishikawa Prefecture and Nyuzen in Toyama Prefecture. This LLS has the advantage that it makes it possible to observe the time and place of the falling of a thunderbolt, its polarity, the high value of the current wave of a lightning stroke, and frequency.

As the result of research conducted until now the following characteristics of lightning in these districts were discovered: 1) there is a tendency that lightning develops mostly inland in summer and it falls into the sea in winter; 2) in winter, 90 percent of lightning is anodic and fugitive; and 3) the value of lightning currents is larger in winter than in summer. The institute intends to continue the observation of lightning and make use of the results in designing thunder-resistant equipment. "We wish to develop a system capable of forecasting the attack of lightning instantly," Hajime Shibata, director of the institute, expressed his hope. Scientifically, lightning remains in the realm of the unknown, so the results of research by the institute are awaited with interest.

Far-Infrared Rays Technology Made Available to Local Industry

In the research areas concerning the efficient use of energy, the improvement of load capacity and the effective utilization of electric power designed for power demand development, the development of a heat pump and the research on the application of electric heating are drawing particular attention.

In the area of the heat pump, the institute has developed its own storage battery-type heat pump air conditioner, which is charged during off-peak hours at midnight by connecting the storage battery with a direct current bus and discharged in the daytime to operate. The institute applied for a patent for it last year. At present, research and evaluation are continued in an

attempt to commercialize it through the further improvement of the performance, economical efficiency, and maintainability of the machine, including the extension of the battery's life.

The institute takes great interest in the research designed to put a heat pump-type snow melting device to practical use. With respect to snow removal methods, the electric heating system called road heating and the snow removing system that sprinkles underground water directly on snow, are still popular. However, the use of underground water may cause a fear about the ill effects such as the lowering of the level of underground water and the subsiding of the ground. So, there is a strong demand for a snow melting method which does not use underground water and is superior to the existing electric heating system in energy efficiency.

The heat pump-type snow melting device was created to meet such a demand. It is troublesome to remove a pile of snow from roofs and roads in snowy countries. So, the device is intended to melt snow with warm water by using a heat pump. If the device is used exclusively for melting snow, it can be qualified for the second snow melting rate. Its low running cost is welcomed by users. The institute intends to conduct proving tests after making thorough examination and evaluation of its design.

With respect to the research on the application of electric heating, the institute is positively engaged in the research on the application of heating by far-infrared rays. Far-infrared rays, by nature, heat the inner part of an object, since their wavelength is relatively long. Making the most of this function, the institute is conducting the research on the drying and processing of painted objects, food, plastics, etc. To give examples of its practical use, a new device employing a far-infrared ray heater is used for baking rice crackers and the hot-drying of painted processed aluminum goods is done by far-infrared rays.

Since this heating technology, which enables energy saving, contributes to the improvement of productivity of the rice-processing industry in the Hokuriku districts' rice producing provinces, it is expected to have far-reaching effects on local glutinous rice producing farmers. Also, the hot-drying of painted aluminum sashes is a new technology valuable to the districts where material manufacturing enterprises are flocking.

Fuel Cell Adopted as Auxiliary Electric Source for Solar Light Power Generation

Even for Hokuriku Electric Power Co., which has a wealth of hydroelectric resources, the diversification of electric sources is a task yet to be achieved to ensure the stable supply of electric power and to reduce the generation cost. The research on the diversification of electric sources ranges over many fields including the research on the technology for assessing the effects the promotion of nuclear power and thermal power generation will have on the environment and the research on new energy.

Among others, the technological development of an independent dispersed-type solar light power generation system, commissioned by the New Energy Development

Organization (NEDO) as part of the "Sunshine Project," a national project, is characteristic.

The experimental equipment for solar light power generation installed in a mountain hut at the foot of Mt. Tateyama is intended for use in remote and secluded places in the mountains. The special characteristic of this equipment is that it is not designed to be installed in a place abundant in sunshine, but intended for the dwellings difficult to obtain power supply from distribution lines.

The structure of this system is not much different from those installed on flat ground, but its solar battery is built in a solar panel incorporated with a roof so that it can be used in winter in snowy countries. Another feature is that a 4 kw phosphoric acid fuel cell is mounted as an auxiliary electric source. By using this system, research is being conducted concerning: 1) the development of the most suitable system technology for operating solar cells, storage batteries, and fuel cells; 2) the verification of durability and safety under severe environmental conditions such as a low temperature and heavy snow; and 3) the simplification of the device and maintenance with a view to lowering the construction cost.

It is 3 years now since this commissioned research work begain in June 1984. It is said that future research themes are to work out countermeasures against the obstruction by snow in order to use sunshine effectively in winter and against seasonal fluctuations of generated energy, which include the adoption of the fittest method to operate auxiliary power sources. The test data available for daylight are not abundant but what are known are valuable. Experts concerned have great interest in the backup effects of the fuel cells.

Coal Ash Used for Making Roofing Tiles

What is noticed in the company's attitude toward technological development is that the company is very enthusiastic about the research subjects closely connected with the interests of the local community. "Technological cooperation with the local community" is stated in the fourth item of the institute's research goals.

As the concrete themes for technical cooperation, the application of a heat pump to the agricultural and fisheries industries and the technological research on the effective utilization of coal ash can be cited.

Coal has no great weight in the company's composition of electric sources, representing 13 percent of the total energy generated, but Toyama Shin-Minato Thermal Power Plant alone produces about 110,000 tons of coal ash a year. Other electric power companies are also utilizing coal ash in reclamation and as a raw material for cement and fertilizer, but this company developed a treatment method to stabilize the soil by using cement mixed with plaster in 1979. This method, which has a stabilizing effect on roadbeds, is very useful in the construction of roads and dams.

Furthermore, as a unique coal ash utilization method the use of coal ash in making high molecular substances (rubber and plastics) and roofing tiles is being studied.

Coal ash contains silica and alumina which are effective in strengthening rubber, and is not harmful to use as a filler. The use of it as a filler is helpful in making products lighter. In the case of plastics, if 5 percent of coal ash is mixed with plastics, it is estimated from Japan's total volume of plastics production that about 400,000 tons of coal ash can be effectively used annually.

In the case of roofing tiles, 10 percent of coal ash is mixed with clay, a raw material, and sintered to make tiles. The mixing with coal ash helps to increase the strength of tiles. Therefore, it is possible to make tiles lighter. Since clay mines producing clay of high quality have been exhausted recently, the utilization of coal ash is attracting attention.

Since the environment for oxidization in the electric sintering furnace was not proper at initial tests, unburned carbon was sintered and gas blew off. As a result, tiles with uneven surfaces were produced. However, the unfailing efforts of researchers prevailed to produce artistic tiles in a beautiful streamline shape. The institute is studying various coal utilization methods other than the above in order to provide coal ash with high added value.

The institute takes great interest in the research on electric cars and the automation of power distribution, and is enthusiastic about the cooperation with Kanazawa and Toyama Universities and prefectural industrial technology centers.

The keynote of management of the electric utility which has in view the cooperation in the promotion of a local community through electric power supply, is well expressed in the company's attitude to go shares with the local community in technological development activities.

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RESEARCH INTO NEW LASER CRYSTAL MATERIAL DISCUSSED

Tokyo OPTRONICS in Japanese Oct 86 pp 51-56

[Article by Ken Ishikawa, Production Technology Research Institute, Toshiba Corp.]

[Text] 1. Outline

Research into new laser crystal materials has been active since the alexandrite laser made its debut as a cold-operating, wavelength variable solid laser with Cr ions as its active ions. New solid lasers are still inferior in average output compared to the Nd:YAG and the CO_2 laser which have advanced their practical use, while studies are being advanced from the standpoints of wavelength-variability, high-density active ion doping, high oscillation efficiencies, enlargement of crystal size, fast growth of crystals, reduced thermal lens action and a new oscillator method. The contents released are:

(1) Nd:BEL and LNA were watched among those using Nd^{3+} as their active ions and new materials as their base materials.

(2) As for materials obtained by doping Nd^{3+} ions together with another for high efficiency, Nd:Cr:GSGG, Nd:Cr:GSAG, Nd:Cr:LNA, and Nd:Sm:CaF_2 were reported.

(3) As for variable wavelength lasers, Fi:Al_2O_3, Cr:GSGG, Cr:GSAG, and Cr:$KZnF_3$ were released.

(4) Among those few released on oscillating equipment and its applications were oscillators of actual-phase lasers such as Q switched lasers--Toshiba Corp.'s dual temperature control type alexandrite laser with an average output of 115 w and Allied Corp.'s thermal conductive air-cooled alexandrite laser with an average output of 4 w. Regarding new solid lasers, the alexandrite laser which entered its practical phase a step earlier than other lasers drew attention.

2. New Crystals Using Nd^{3+} Ions

French LETI-IRID-CEA's C. Wyon, and others, (TUK35) released the crystal pull and optical characteristics of Lantanide hexaaluminate $La_{1-x}Nd_xMgAl_{11}O_{19}$ (LNA). It is a promising laser crystal for high output, featuring chemical stability,

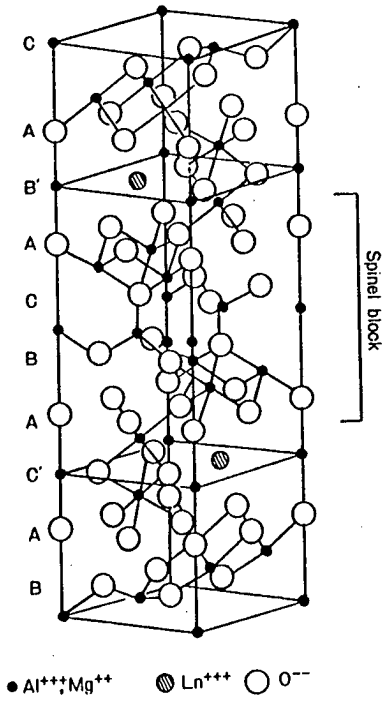

Figure 1. Unit Cell of $LaMgAl_{11}O_{19}$ (magnetoplubite type)

function of hard (9 Mohs), high-density uniform Nd doping at a low melting point (1,870°C) compared with Nd:YAG, and low-cost manufacturing available from oxides. It can be grown by the Cz method, its pull speed and revolution are 2 mm/h and 25 rpm, respectively, and its crystal pull direction is at a right angle to the axis C. Its structure is shown in Figure 1. A 70-mm-long crystal with a diamter of 5 mm has been formed. Figures 2 and 3 show its spectral characteristics and repartition along LNA, respectively, where Nd is uniformly partitioned longitudinally. Figure 4 shows its output characteristics. It is equivalent to that of YAG, its threshold regarded as reduceable by crystal improvement.

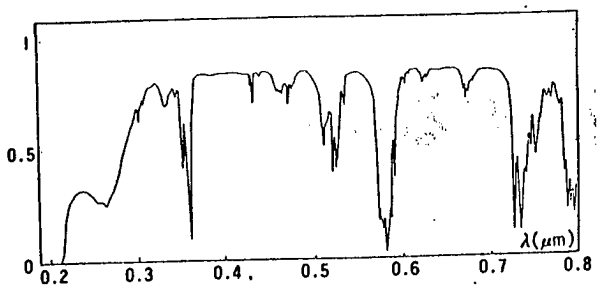

Figure 2. Visible Transmission Spectrum of an LNA Sample (e#5 mm)

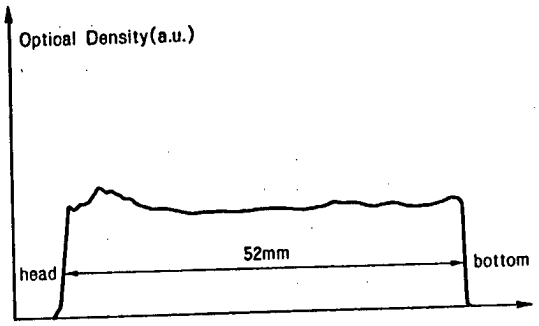

Figure 3. Neodymium Repartition Along an LNA Rod

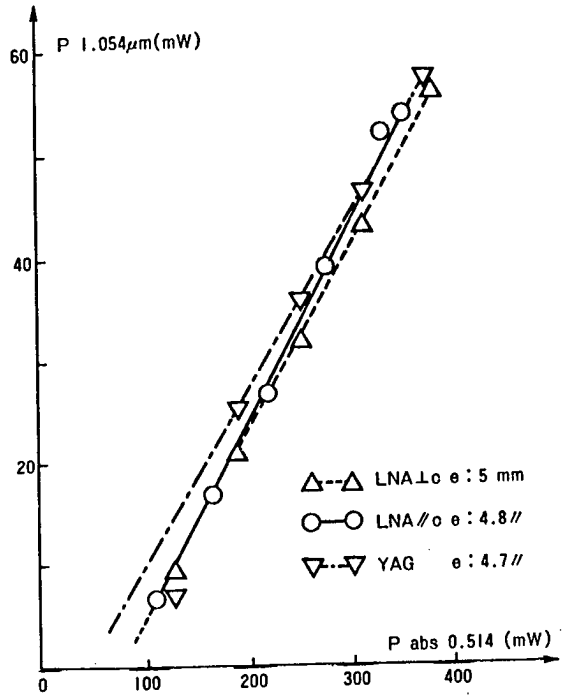

Figure 4. 1.06 μm Laser Output Power vs Effective Absorbed Pumping Power LNA (10 percent Nd), YAG (0.8 percent Nd)

The laser, as shown in Figure 5, can tune with 80 Å and 35 Å tuning areas at 10820 Å and 10545 Å, respectively (WQ-5). CW excitation of a 1-cm long crystal with an Ar ion laser and with a Kr ion laser permitted 10 and 26 percent slope efficiencies to be obtained. The tuning characteristic above was obtained by oscillating four double refraction filters inserted into a resonator for wavelength tuning.

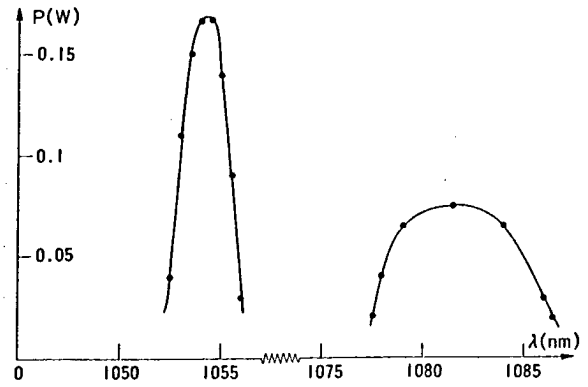

Figure 5. LNA Wavelength Tuning Characteristics

In CW oscillation by Kr arc lamp excitation, a linear polarized light output of 66 mW with a wavelength of 1,054 nm was obtained using two 3 kw lamps by inserting a 32-mm long LNA rod into an Nd:YAG system with a crystal length of 92 mm, with the then threshold being three times as large as that of YAG. Small in density quenching, LNA permits six-times doping of Nd density compared with Nd:YAG. Therefore, though small in size, it permits high-efficiency oscillation, and is also a promising crystal for diode pumps. A wavelength of 1,054 mm tuning with phosphate system glass, is also promising for oscillators. As for its wavelength tuning characteristics, its 1,083 nm can be used for photoexcitation of He_3 and He_4 and applied to polarization of electron spin or nuclear spin.

Allied Corp.'s T. Chin and others (WM2) unveiled Nd:$La_2Be_2O_5$ (BEL), featuring small double refraction in photoexcitation, weak thermal lens action, a large amount of energy storage, photoexcitation efficiency between Nd:YAG and Cr:Nd:GSGG with a high photoexcitation efficiency and mechanical and thermal properties between its relatively inferior YLF and its superior YAG. These characteristics are convenient for a laser aimed at obtaining an average output of low energy and a medium level or below to be used for the Q switch to obtain low-order modes and high luminance. Belonging to the monoclinic system, BEL is biaxial, with its dn/dt, photoaxial temperature dependence of a refractive index, having plus or minus depending on photoaxial directions and showing 0 in a direction off the main axis. Thermal lens action from a rod type laser is caused more by dn/dt than by thermal expansion deformation so that BEL's properties can permit lens action to be reduced by selecting crystal orientations.

As stated above, both LNA and BEL are evaluated against Nd:YAG's characteristics. Nd:YAG may not be replaced immediately by them; however, the European Eureka Programs are hastening to form a group to further a project aimed at improving LNA to 3 kw output in 3 years and 5 kw output in the future.

3. Trend Toward High Efficiency

Cr^{3+} ion's wide absorption spectrum largely overlaps the emission spectrum of an excitation lamp, Cr:Nd:GSGG provides good excitation efficiencies and a study is underway to pursue its high efficiencies versus Nd:YAG.

Spinder & Hoyer's P. Fuhrberg and others (THBI) made a comparison as shown in Figure 6 using four types of rods--Nd:YAG (ϕ6 x 75 mm), Nd:Cr:GSGG (ϕ6 x 75 mm), alexandrite (ϕ5 x 75 mm), and Cr:DSAG. In single oscillation, Nd:GSGG provides an oscillation efficiency about twice as large as that of Nd:YAG, while the efficiency decreases under an oscillation condition of high average power. Measurement was made on the assumption that this was caused by thermal lens action from strong rods. As a result, it was found that a new garnet crystal had strong lens action of about seven times 30-100 J. This was because of an increase in thermal load caused by photoabsorption by a color center formed in the crystal by a wide wavelength area of photoirradiation and by Cr^{3+} ions. This thermal load could be reduced by cutting off short wavelengths below 400 mm. An input of 120 J made Nd:YAG show 40 percent input saturation when it was extended from a spot with a small input, but this could be eliminated by cutting off UV light. Meanwhile, with Cr:ND:GSGG, 30 percent of the output remained saturated.

Hughes Research Laboratory's D.S. Sumida and others (WQ3) measured small signal gain with a rod size of ϕ6 x 75 mm at an output having Q switch pulse sufficiently damped, concerning an excitation efficiency of Cr:Nd:GSGG by dependence of the Cr density. As a result, it has been found that in densities of $1\text{-}2 \times 10^{20}/cm^3$, larger Cr densities result in a slightly increased excitation efficiency but not much dependence and that a Cr:Nd:GSGG rod of the same size as Nd:YAG permits about twice the energy storage as the latter.

Quantronix's J.Y. Liu and others obtained a slope efficiency of 7 percent and a total efficiency of 6 percent with a rod size of ϕ6 x 79 mm, using Cr:Nd:GSGG; however, a higher efficiency than Nd:YAG was obtained as a result in areas with low average power. Operation was made with rod sizes of 64 x 75 mm and ϕ6 x 75 mm and at an output of 2 kw. Under conditions of a pulse width of 0.5 ms and a repetition rate of 6 Hz, 16 and 21 percent became heat with ϕ4 and ϕ6 rods, respectively. The heat rate was three times as large as Nd:YAG. The total efficiency and the slope efficiency in normal pulse oscillation were 3.6 and 4 percent with a ϕ4 rod and 2 and 2.5 percent with Nd:YAG. High average output operation was limited due to thermal lens action and thermal induced stress. Though its thermal lens action was said to be seven times as great as Nd:YAG in another report by E. Reed and others, it was, in fact, as great as 10 times. In kw-level oscillation, an area corresponding to 50 percent of a destructive strength was reached, while the rod was sometimes damaged during the experiment. For improved destructive strength resistance, microcracks on the rod's surface are to be removed to improve their resistance to the stress destructive limit.

Cr^{3+} is effective as a sensitizer in some oxide crystals, while it is not incorporated under a crystal field proper for Nd^{3+} sensitization in other crystals. In this context, LLNL's S.A. Payne and others selected and studied

Sm as a material suitable for fluoride crystals with a low nonlinear refractive index. When bivalent Sm was incorporated into fluoride, it strongly absorbed visible UV light to show red luminescence, which overlaps largely with an Nd^{3+} absorption line, thereby functioning effectively for excitation. Its absorption, discharge, and energy transfer efficiencies were shown.

LLNL's M.D. Shinn and others (TUBB2) considered that Cr:Nd:GSGG would be effective for some applications, but its induced emission cross section and nonlinear refractive index were too large for it to be suitable for use in laser nuclear fusion in terms of laser characteristics, and studied $LaMgAl_{11}O_{19}$ obtained by doping Cr^{3+}:ND^{3+}. As a result, it was observed that its crystal is equal to YAG in thermal and mechanical properties, 20 percent higher in the normal pulse oscillation efficiency and has its induced emission cross section (0.2×10^{-20} cm^2) and nonlinear refractive index ($n_2^e = 2.6 \times 10^{-13}$ esu) within the allowable values for nuclear fusion. Energy transfer from Cr^{3+} to Nd^{3+} was also observed, together with its transfer efficiency upper limit of 90 percent and the total transfer efficiency of around 40 percent.

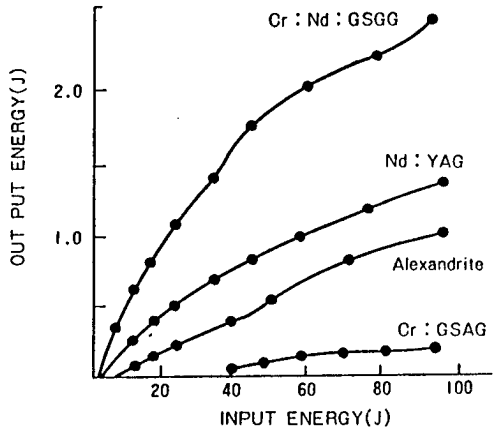

Figure 6. Characteristics of Various Rods

4. Trend of Wavelength Variable Solid Lasers

Presentation was mainly made on those using Ti and those using Cr for their active ions.

MIT Lincoln Laboratory's A. Sanchez and others (THB3) succeeded in their laser oscillation by Ti:Al_2O_3 at room temperature oscillation. CW oscillation by Ti:Al_2O_3 had been conducted by cooling liquid nitrogen, while they made oscillation by Lincoln Laboratory-made crystals and obtained an output of 1.6 w through Ar ion laser excitation at an input of 12 w. The rod is 1.8 cm long with the square section of 1 cm. At its end is mounted a three-mirror folded resonator having undergone optical polishing in Brewster's cut as shown in Figure 7. The crystal is set on its beam waist part and excitation light is

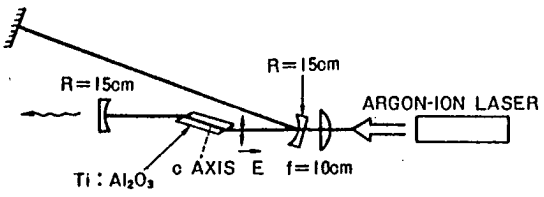

Figure 7. Schematic of Experimental Setup Showing Ar-ion Pump Laser and Three-Mirror Folded Cavity for Ti:Al_2O_3 Laser

converged through a lens from the folded mirrors with an excitation light transmissivity of 89 percent to be irradiated. The laser rod absorbs about 70 percent light at its 120-μm diameter linear part, its threshold, slope efficiency and slope quantum efficiency being 2.3 w, 20 percent and 44 percent, respectively (see Figure 8).

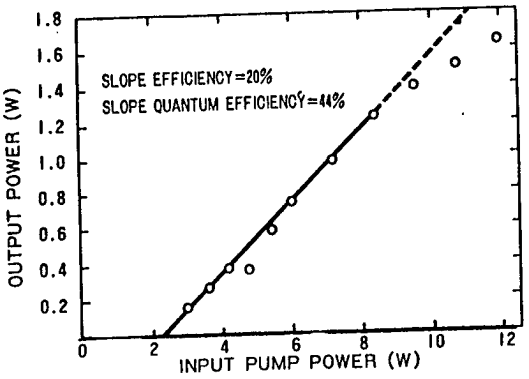

Figure 8. THB3 Output Power at 780 nm From a cw Room-Temperature Ti:Al_2O_3 Laser vs Incident Pump Power From an All-Line Ar-ion Laser

The Naval Research Laboratory's L. Esterowitz and others (TUK27) obtained an average output of several watts using a Ti:Al_2O_3 laser in high average output operation by flashlamp excitation, and the lamp lives of 10^5-10^6. Life of a flashlamp designed for dye lasers is 10^3 for input conditions of 2-10 J/cm. They made a specially designed thick pipe shock-resistant, flowed a shimmer current (3-5 A) through it, and obtained life at 0.25×10^6. Lamp life is equal to the value regulated for a 30 percent decrease in light quantity. The cause of the decrease in output is currently being studied by analyzing in-pipe lamp deposits while it is believed that it is because SiO_2, the pipe material, resolved to form Si.

Rocked Missiles Space Co.'s A. Driscoll and others (TUK29) obtained slope efficiencies of 19 percent (OC, 60 percent) and 31 percent (OC, 50 percent) at a wavelength of 750 nm by exciting Ti:Al_2O_3 with a 522-nm pulse laser. They have found that oscillation is also possible by Ti:YAG and that the center wavelength of fluorescence is 750 nm for Ti:Al_2O_3 and 770 nm for Ti:YAG.

U. Hamburg's J. Drube and others (THB4) reported flashlamp excitation characteristics of Cr^{3+}:GSGG and Cr^{3+}:GSAG: With Cr:GSAG, as against Cr:GSGG, color center generation by UV irradiation reduces and oscillation is possible with a flashlamp which does not cut off UV rays; however, addition of UV cutoff dye to cooling water can permit better results. It is capable of tuning at wavelengths of 750-800 nm, permitting an output of 206 mJ to be obtained with a rod size of $\phi 5 \times 50$, Cr^{3+} density of $5 \times 10^{19} cm^{-3}$ and resonator-mirror transmissivities of 5-7 percent, for a slope efficiency of 0.24 percent and wavelength of 780 nm. AR coasting applied to the laser rod end face is responsible for an output as low as 200 mJ; i.e., sufficient optimization for higher outputs have not been made. Figure 9 shows its input/output characteristics.

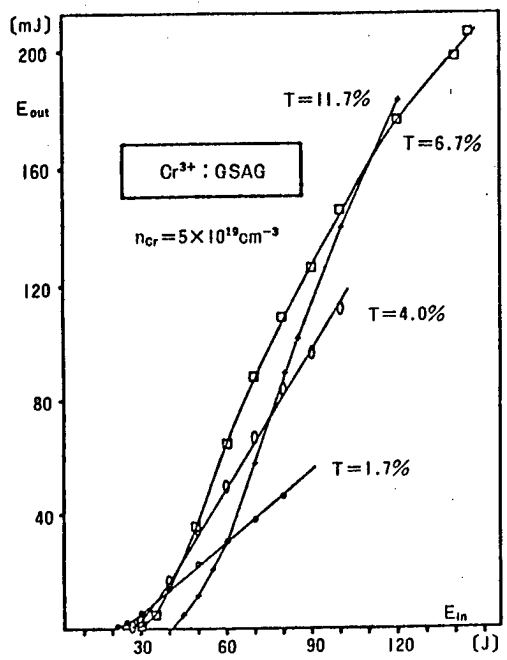

Figure 9. THB4 Performance of 2-Inch Long Cr:GSAG Laser Rod Pumped by a Xenon Flashlamp in a Single-Elliptical Pump Cavity

R-S-R-E's M. Payne and others (TUK31) showed that absorption occurs by UV irradiation with undoped GSGG, the absorption peak was shown in a wavelength of 1,700 nm, and an absorption reduction trough was in a wavelength of 790 nm in annealing. They also showed that increased output could be obtained with Cr:GSGG with a rod size of $\phi 6.35 \times 76$ mm by eliminating short wavelengths below 550 nm with a filter. Its slope efficiency was lower than that of an alexandrite laser, and its threshold was also lower.

Allied Signal's B. Chai and others (THB5) reported on a Borate Cr:$ScBO_3$ laser capable of tuning at room temperature which was excited by Kr-ion laser's wavelength (647 nm) and permitted normal oscillation at a wavelength of 843 nm. It could tune at wavelengths of 787-892 nm with one double refraction filter, Cr^{3+} ion's $_4T_2$ fluorescence expanded over wavelengths of 720-1,000 nm, its peak was found at 815 nm, and the life of fluorescence was 115 μs.

5. Oscillating Units and Their Applications

Of new solid lasers, the most advanced in practical use is the alexandrite laser. Toshiba Corp. (TUK30) obtained an output of 2 w, using an Allied Corp. made rod, with an average output of 115 w, normal pulse output of 8.5 J, wavelength tuning areas of 715-805 nm, line width of 60 GHz, wavelength of 755 nm, and an average output of 35 w at 15 GHz. The oscillator, as shown in Figure 10, has in its laser head two systems of water-cooled channels--a hot water circulating laser rod system and a room temperature circulating Ce-doped Xe flashlamp system, which are installed in an ordinary resonator or one provided with a wavelength selective element. Figure 11 shows its input/output characteristics. An oscillation efficiency of 3.3 percent was obtained with a rod size of ϕ6.3 x 102 mm, with its wavelength tuning characteristics and temperature characteristics of rod cooling water against the laser output shown in Figures 12 and 13, respectively. Figure 14 shows a processing application example using this oscillator where clear marking as thin as 20 μm, thinner than by a $TEACO_2$ laser, is permitted in such architecture. In comparison with Nd:YAG, alexandrite permits marking of a 20 percent larger area under the same pulse width and energy conditions, due to its spike waveform pulse. It was also found effective for drilling operations. Figure 15 shows the number of laser pulses needed for the completion of a through hole in Hastelloy-X by drilling from various incident angles. As its wavelength is shorter than Nd:YAG, it is effective for drilling copper, brass, and aluminum. As for its applications by utilizing its characteristics as a wavelength variable laser, what are applicable on an industrial level is not clear yet, while various proposals have been made for its chemical applications: There are 794.76-nm D_1 line and 780.02-nm D_2 line in the alexandrite laser oscillation wavelength area. Irradiation of a laser beam corresponding to D_1 line on Rb steam by right circle polarization permits Rb to be excited and polarized on a specific spin level.

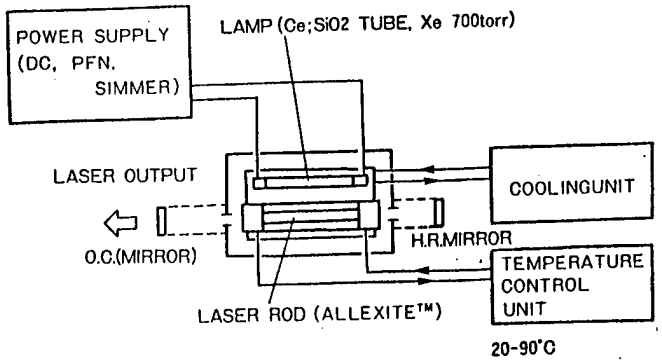

Figure 10. Schematic Diagram of Alexandrite Laser

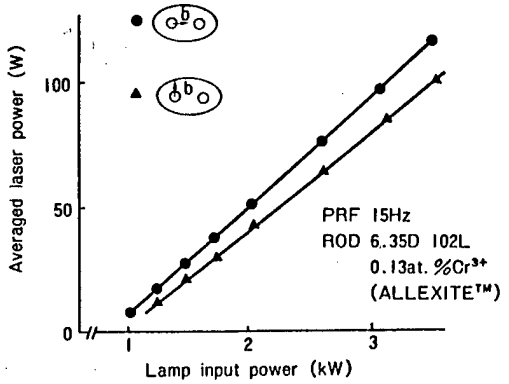

Figure 11. Performance of Alexandrite Laser

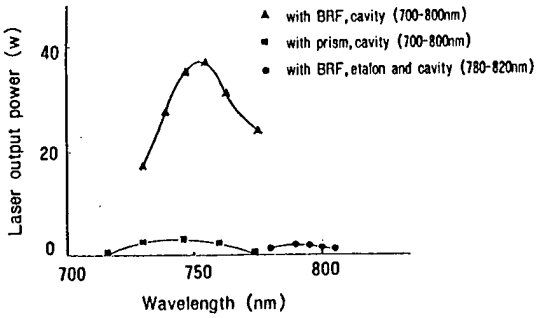

Figure 12. Experimental Result of Alexandrite Lasers

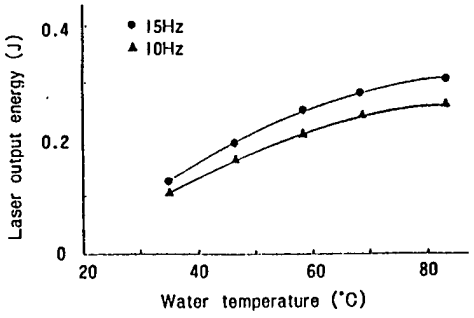

Figure 13. Temperature Dependence of Output Energy (Lamp input energy is fixed at 60J)

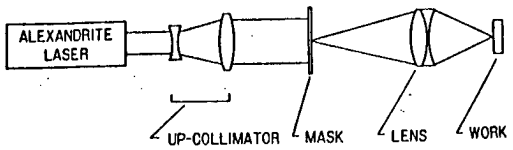

Figure 14. Schematic Diagram of Marking Experiment

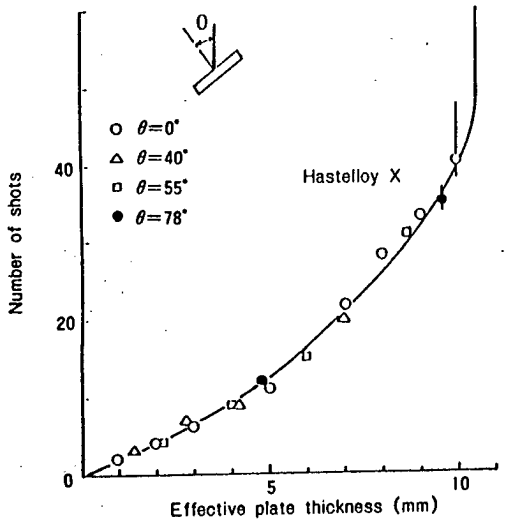

Figure 15. Drilling Performance on Hastelloy-X (Energy:3J, PRF: 1 Hz)

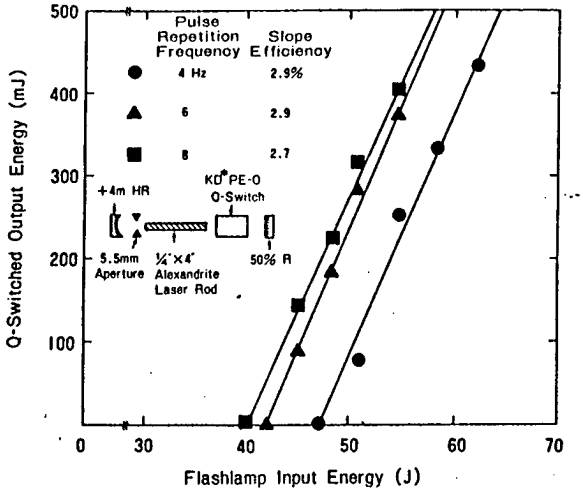

Figure 16. Q-Switched Laser Performance

Allied Corp.'s J.W. Kuper and others (TUK28) excited a thermal conductive type cooling Q switched pulse oscillator by a multilayer coating-applied Xe flashlamp with a rod size of ϕ6.3 x 102 mm and obtained an output of 0.5 J, pulse repetition rate of 8 Hz, slope efficiencies of 2.7-2.9 percent, and the total efficiency of over 1 percent in Q switch action. The unit is portable and compactly designed. Its characteristics are shown in Figure 16.

While conventional slab type lasers have architecture where incidence of flashlamp-excited light is made at a square-section total reflecting surface, Litton Laser System's M.A. Acharekar and others (WQ4) presented architecture introducing flashlamp light from, not a total reflecting surface, but an end side through a prism. The size of its slab is 8 mm x 16 mm x 140 mm, for the end side, total reflecting surface and length in that order, and its two excitation lamps are arranged in double elliptical cylindrical mirrors, permitting high-efficiency oscillation. To eliminate parasitic oscillation in a slab crystal, AR coating was applied against 1.06-μm vertical incidence. One-way thermal stationary state was obtained in the abovementioned architecture. In addition, a pulse amplification output of 0.5 J was obtained at 20 Hz using it as an amplifier. Its beam has characteristics of surpassing directivity close to the diffraction limit.

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HIGH THERMAL CONDUCTIVE ALUMINUM NITRIDE DISCUSSED

Tokyo CERAMICS JAPAN in Japanese Dec 86 pp 1130-1135

[Article by Kazuo Shinozaki and Akihiko Tsuge, Research and Development Center, Toshiba Corp.: "Characterization Techniques of Ceramics--Development of High Thermal Conductive Aluminum Nitride"]

[Text] Thermal conductivity is one of the most important properties of ceramics. Their application varies widely from low thermal conductive insulation brick for electric furnaces to semiconductor substrate materials for which a high heat-releasing characteristic is required. This article introduces recently appeared high thermal conductive aluminum nitride (AlN) as a material for semiconductor substrates by discussing factors involved in the improvement of its thermal conductivity.

1. Introduction

The major high thermal conductive material for semiconductors to date has been BeO, application of which was limited due to its high toxicity and cost. Following the development of high thermal conductive SiC[1], high thermal conductive AlN has been developed recently[2], prompting the application of high thermal conductive ceramics to substrates and packages for semiconductors.

AlN is expected to have a thermal conductivity more than 10 times higher than Al_2O_3[3] and its electric properties are about the same as Al_2O_3. Thus this material is suitable for use in high heat-releasing/electricity-insulating purposes. Other features of AlN include heat expansion rate smaller than Al_2O_3, good coordination with Si semiconductors, and high mechanical strength. AlN, although having such excellent characteristics, has been only partially used for thyristor insulation board[4]. This is because the thermal conductivity of sintered AlN is far below the expected level (about 40-60 W/m·K). The reason is that AlN is hard to sinter and its impurities are prone to solve in solids.

AlN has been made highly thermally conductive mainly by 1) developing high purity fine powder materials, and 2) examining the condensing agents which take in the impurities in the form of compounds and thus help improve the thermal conductivity. This manuscript will first cover briefly the thermal conductivity of insulation ceramics and then present considerations relative to AlN thermal conductivity improvement.

2. Thermal Conductivity of Insulation Ceramics[5)]

Factors involved in thermal conduction of materials include phonon, electron, exciton, photon, magnon and ion. Assuming that the contribution of respective factors i to thermal conductivity is additive to the material's thermal conductivity k, the k is expressed as follows:

$$\kappa = 1/3 \sum_i \int_0^{\omega_m} c(\omega) \cdot v(\omega) \cdot l(\omega) d\omega \qquad (1)$$

Thermal conductivity of electrical insulating ceramics is in general controlled by free phonons. In this case c(w) in the equation (1) refers to the contribution to specific heat by phonon whose angular frequency is w, v(w) refers to phonon's group velocity, ℓ(w) refers to mean free travel and w(m) represents Debye frequency $K\theta_D/h$ in Debye model.

Consider the requirements for high thermal conductive materials with insulation characteristics. Specific heat c is 0 at OK, increases with temperature, and converges at a certain value regardless of the type of material. Therefore, we cannot expect a remarkable difference depending on the materials. According to the Debye model, group velocity v is a constant value which does not depend on the frequency w and its temperature dependency is slow. The v varies, however, from material to material; it becomes larger with crystals whose atomic weight is smaller and interatomic bond is stronger, with θ_D a standard value. The mean free travel ℓ changes widely depending on the type of material, regularity of lattice, amount of impurity atoms; and when the material is ceramics it depends on the microstructure of the surface and the grain boundary etc. The ℓ is proportional to 1/T when the temperature T is higher than θ_D. When the temperature is lower, the phonon clash rate decreases, ℓ levels are off due to the impurities and crystal boundary and becomes close to the constant value.

Thus high thermal conductive material with insulation characteristics must meet the conditions of:

(1) light atoms,

(2) strong interatomic bond,

(3) simple crystal structure,

(4) highly symmetrical lattice vibration, etc.[6)]

Among the insulators, diamond is well known as a high thermal conductive material. Other materials in this group include cBN, SiC, BeO, BP, AlN, BeS, Si, GaN, GaP and Ge. These materials meet the above requirements in that they form strong covalent bonds and similar relatively simple structures (adamantine structure) such as diamond type, ultz ore type and zincblende type etc.

Thermal conductivity of these materials is expressed as follows[6,7]

$$\kappa = BM\delta\theta_D^3/T\gamma^2 \quad (2)$$

where M is mean molecular weight of the unit lattice, δ is cubic root of the volume occupied by one atom in the unit lattice, T is absolute temperature, γ is Gruneisen constant, and B is the constant value. Figure 1[3] shows the relationship between the theoretical thermal conductivity (uses actually measured thermal conductivity as the base and undergoes adjustment for the decline in the conductivity due to the contained impurities and also due to the isotopes contained in the constituting elements) of these materials at 300K and $M\delta\theta_D^3$. This figure demonstrates that equation (2) is well realized, and identifies the positions of diamond (2000 W/m·K), SiC (490 W/m·K), BeO (370 W/m·K), AlN (319 W/m·K), etc.--the materials which are currently drawing attention as raw materials of high thermal conductive substrates (the values have not undergone adjustment for thermal conductivity reduction due to the isotopes).

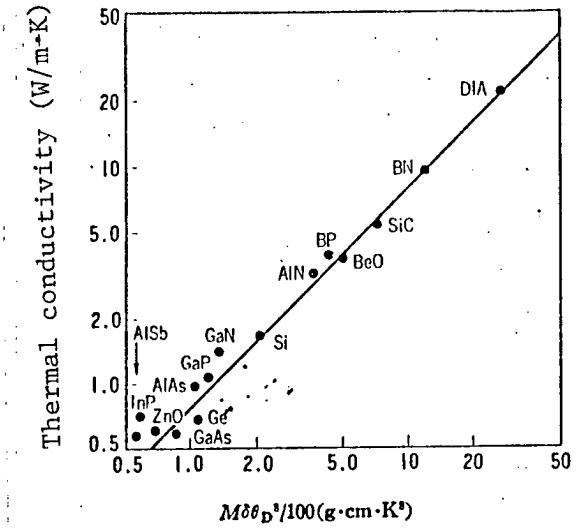


Figure 1. Relation between thermal conductivity of adamantine structure material at 300K and Leibfried-Schlomann parameter $M\delta\theta_D^3$ [3]

3. Improvement in Thermal Conductivity of Aluminum Nitride Ceramics

3.1 Factors To Lower Ceramics Thermal Conductivity and Methods To Analyze Them

Raising the thermal conductivity of AlN can be achieved by eliminating the phonon diffusion factor in the equation (1). As specific reasons for a reduced thermal conductivity, various factors as shown in Figure 2[8] are considered. For instance, ceramics made of inferior crystals with distortions, dislocations and defective lattices show large phonon diffusion. Phonon diffusion is also caused by a solid solution of impurities. Ceramics which are not dense enough contain pores and cracks to lower the thermal

conductivity; and when containing the low thermal conductive second phase, the thermal conductivity of sintered ceramics as a whole becomes low. On the other hand, the larger the grain size the better the thermal conductivity, although this poses another problem of declined mechanical characteristics (such as strength).

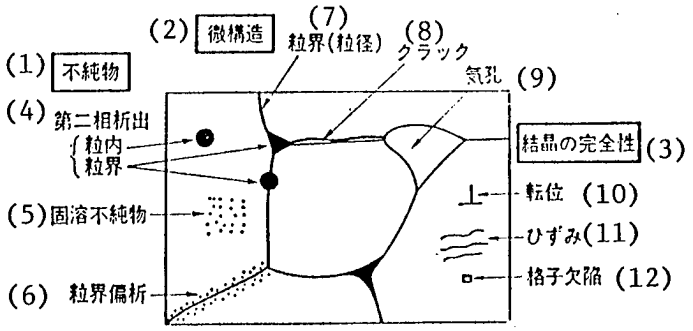


Figure 2. Factors which lower thermal conductivity of ceramics[8)]

Key:

1. Impurities
2. Microstructure
3. Complete crystallization
4. The second phase precipitation
   { Grains
   { Grain boundary
5. Solid solution of impurities
6. Grain boundary segregation
7. Grain boundary
8. Crack
9. Pore
10. Dislocation
11. Distortion
12. Defective lattice

The basic evaluation methods are: evaluation of the sintered conditions as to density, and contraction coefficient etc.; determination of thermal conductivity; and observation of the microstructure, etc. Among these methods, the thermal conductivity is usually determined by measuring the thermal diffusion rate using the laser flash method and calculating with specific heat and density measured by the same or other methods. The thermal conductivity determination by this method is carried out based on a mathematical hypothesis that the evenly distributed light is given in zero pulse wavelengths to a parallel, flat sample of infinite size. In practice, however, strength distribution of the laser light is considerably wider. Also, as the thermal diffusion rate of the sample increases, the laser pulse wavelength substantially influences as an error factor (usually about 200 W/m·K or more). In addition, there are many other problems including that high thermal conductive AlN is translucent and thus if the light is not sufficiently shielded it may have heat-source distribution within the sample to constitute an early stage condition. Since the variance due to these factors amounts to 10 percent or more of the measured value in some cases, it is hoped that a measurement method be established and the methods used in different research facilities be unified.

To analyze the phonon diffusion factors, various methods so far presented in this lecture series are useful. For instance, through SEM and TEM observation,

information on the microstructure can be obtained as to the existence and status of pores and cracks, how the secondary phase exists, thickness of the grain boundary layer, and dislocations and distortions. The analytical electronic microscope (STEM + EDX) makes it possible to observe the solid solution status of the impurities and the grain boundary segregation, etc.; the X-ray diffraction serves to identify and qualify the secondary phase of the impurities and to analyze the status of impurity solid solution into AlN which is obtained by measuring the lattice constant. Apart from chemical analyses, oxygen analysis by way of neutron radiation analysis among others is important.

3.2 The Impact of AlN Density and Impurities on Thermal Conductivity

AlN, highly covalent and without a melting point, is difficult to densify. The impurities contained in the raw material powder tend to solve into AlN grains upon sintering or react with AlN to cause solid solutions or compounds with low thermal conductivity.

3.2.1 Relationship Between AlN Density and Thermal Conductivity

According to Kingery[9] the following relationship exists between the pore rate and thermal conductivity for sintered materials.

$$k_s = k_m/(1-P) \tag{3}$$

where k_s is thermal conductivity when the material is completely dense; k_m and P are thermally conductive and their pore ratio subject sample respectively. The relationship between the density and thermal conductivity when AlN (with 3.5 wt percent of oxygen) is added with a sintering auxiliary Y_2O_3 (1-5 wt percent) and is sintered under normal pressure is shown in Figure 3[10]. The figure demonstrates that the density and the thermal conductivity have a good linear relationship when the density is below the theoretical density (about 3.3 g/cm^3). In other words, condensation is an essential requirement for high thermal conductive applications.

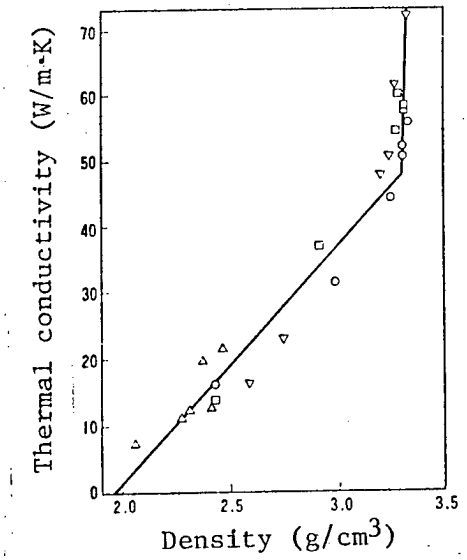


Figure 3. Relation between density and thermal conductivity of Y_2O_3-added AlN normal pressure sintering material[10]

3.2.2 AlN Condensing Auxiliary Agents

Because AlN was studied in the past as a heat resistant structural material, many agents were examined as sintering agents to condense or strengthen the material[11]. Research with attention given to thermal conductivity however are relatively small in number. Table 1[12] shows the density and thermal conductivity (room temperature) of AlN (with 3.5 wt percent oxygen) after being added to respective compounds (3 wt percent) and sintered under normal temperature (at 1800°C). It is learned from the table that AlN must be made dense in order to achieve a high thermal conductivity and that the additives effective for condensation give different influences to the thermal conductivity depending on the auxiliary agents. The additives effective to make the material dense or highly thermally conductive are oxides of rare earths and alkaline earths, among which Y_2O_3 and CaO are conspicuously effective.

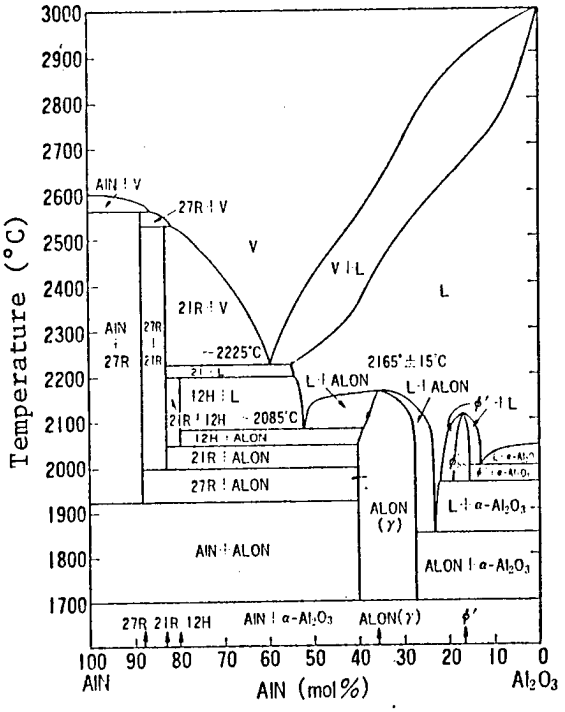
Table 1. Effects of Additives on AlN Condensation and Thermal Conductivity

	Additives	Density (g/cm^3)	Thermal conductivity (W/m·K)
I	$CaCO_3$	3.21	75
	$SrCO_3$	3.26	55
	$BaCO_3$	3.10	60
	$CaC_2O_4 \cdot H_2O$	3.12	63
	$SrC_2O_4 \cdot H_2O$	3.19	41
	$BaC_2O_4 \cdot H_2O$	3.26	58
	Y_2O_3	3.29	72
	La_2O_3	3.33	62
	CeO_2	3.29	53
	Pr_6O_{11}	3.29	56
	Nd_2O_3	3.29	53
	Sm_2O_3	3.29	51
	Gd_2O_3	3.28	50
	Dy_2O_3	3.28	50
	NiO	3.07	42
	$Ce_2(C_2O_4)_3 \cdot 9H_2O$	3.30	59
II	TiO_2	2.64	18
	ZrO_2	2.84	23
	HfO_2	2.80	22
	$MnCO_3$	2.77	21
III	Li_2CO_3	2.18	5.9
	$MgCO_3$	2.31	6.0
	$MgC_2O_4 \cdot 2H_2O$	2.13	5.1

I: Group of additives effective for condensation and improvement of thermal conductivity
II: Group of additives without specific effects
III: Group of additives which hinder sintering and reduce thermal conductivity

3.2.3 Impurities To Hinder Thermal Conductivity of AlN

The impurity that hinders thermal conductivity most is oxygen. The AlN powder reacts with water and oxygen in the air relatively easily and forms hydroxides and oxides on the particle surface. The commercially available AlN raw material powder contains 1-2 wt percent of oxygen depending on the production process and particle size. Also it is highly possible that oxygen is mixed during the manufacturing process of the sintered material. Oxygen as an impurity, shown in AlN-Al_2O_3 System Condition Chart (Figure 4[13]), reacts with AlN upon sintering and solves into the N-site, or produces AlON (spinel) and 27R poly type, etc. The volume of oxygen to be solved into AlN[14] is said to be around 2 x $10^{21}/cm^3$ (approx. 1.6 wt percent) at 2000°C. The relation between the oxygen solid solution and the thermal conductivity is being examined by Slack[14] and Sakai[15]. Figure 5[15] shows the relationship between the oxygen amount and the thermal conductivity in the AlN sintered material (hot-press), revealing that the thermal conductivity substantially declines following the decline of the oxygen amount.



AlN-Al_2O_3 compounds		
Composition	Microstructure	AlN (mol%)
AlN	2 H	100
$Al_9O_8N_7$	27 R	88
$Al_7O_8N_5$	21 R	83
$Al_6O_8N_4$	12 H	80
$Al_{23}O_{27}N_5$	ALON (γ)	35.7
$Al_{22}O_{30}N_2$	φ' Spinel	16.7
Al_2O_3	Corundum	0

Figure 4. AlN-Al_2O_3 System Condition Chart[13]

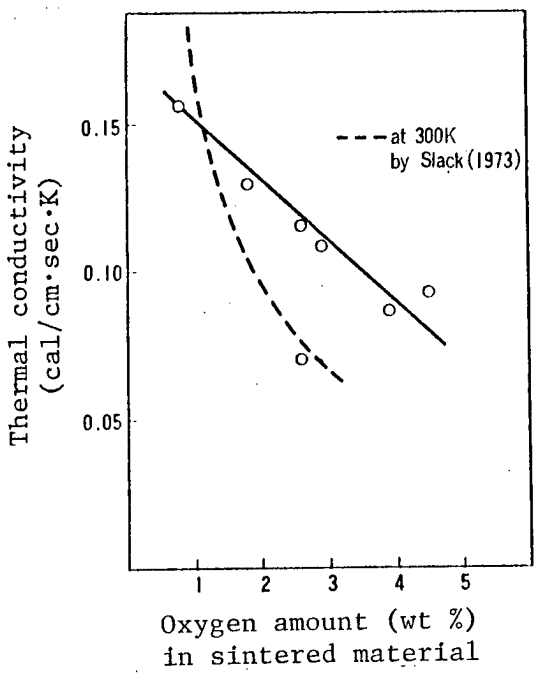


Figure 5. Relation between thermal conductivity and contained oxygen amount of hot-pressed AlN at 295K[15)]

C, Si, Fe and Mg, etc. are pointed out as other impurities to lower the thermal conductivity[2,14,16)]. Particularly C and Si hinder the sintering process itself when their amount is increased.

3.3 Thermal Conductivity Improvement by Excessive Addition of Sintering Auxiliary

Although Y_2O_3 and CaO have been presented as effective sintering auxiliaries, auxiliary agents are impurities to AlN. Thus it is considered that the amount of auxiliaries to be added should be the minimum required to make the material dense so that they do not hamper the thermal conductivity. The author however found that the material added to the auxiliary shows an improved thermal conductivity when compared with the hot-pressed material which achieved the same degree of condensation without the auxiliary, and that when the auxiliary is added in excess of the minimum requirement for condensation the material shows a better thermal conductivity[10)]. Figure 6 shows changes in density and thermal conductivity at room temperature when AlN samples, with different amounts of oxygen contained as an impurity, are added with Y_2O_3 and sintered under normal pressure. It is learned from the figure that an addition of 0.5-1 wt percent of Y_2O_3 is enough to make the materials dense. On the other hand, the thermal conductivity, which rapidly increases as a result of the material becoming dense when Y_2O_3 addition is 0-1 wt percent, also grows though mildly when the Y_2O_3 amount is further raised.

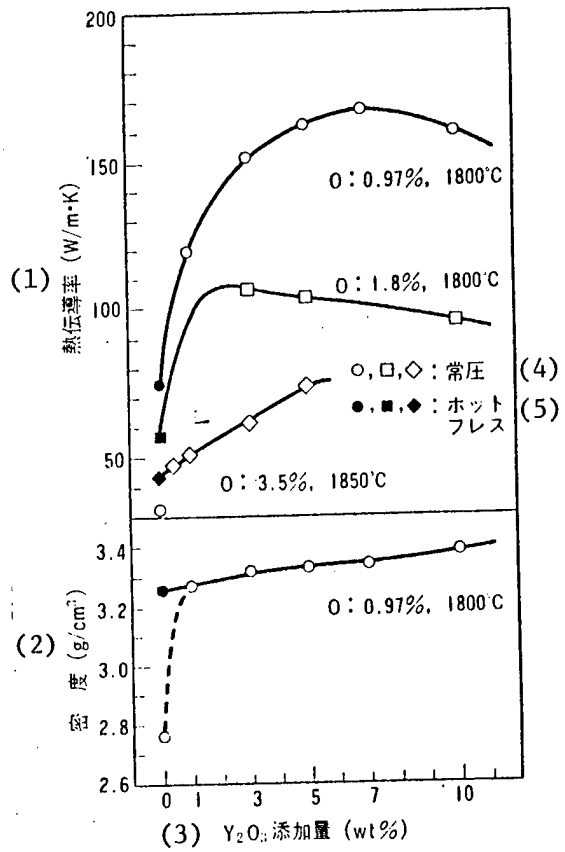


Figure 6. Changes in density and thermal conductivity against the additive amount when Y_2O_3 is added to AlN raw materials with different oxygen impurity levels[17)]

Key:

1. Thermal conductivity (W/m·K)
2. Density (g/cm^3)
3. Y_2O_3 addition amount (wt %)
4. Normal pressure
5. Hot-press

As a result of the examination conducted for this reason, it is known: 1) the added Y_2O_3 and the impure oxygen react to cause a liquid phase and AlN becomes dense due to the liquid phase sintering mechanism; 2) in the final sintered material, Y_2O_3 hardens at the end or the corner where many particles meet in the form of yttrium/aluminum compounds (such as $3Y_2O_3 \cdot 5Al_2O_3$(YAG), $YAlO_3$) while trapping the oxygen (Figure 7[18)] [photo not reproduced]); and 3) other impurities (such as Fe and Si) are taken into the liquid phase in the same manner. Because of these reasons AlN becomes highly pure in the sintered material added with an excessive amount of the auxiliary, and the grain boundary phase precipitates in a way which basically does not impede the thermal flow, resulting in higher thermal conductivity.

3.4 Improvement of Thermal Conductivity by Developing High-Purity, Fine Powder Raw Materials

The well-known production processes of AlN raw material powder are, as that of Si_3N_4, direct nitrification of Al metal ($Al + 1/2N_2 \rightarrow AlN$), and carbon reduction nitrification of aluminum compounds. The nitrification reaction in the direct nitrification method is a pyretic reaction where Al melting point is close to the nitrification temperature and thus the synthesized powder is prone to harden, generally requiring the pulverization process. Making the grain size fine to cope with the problem results in the disadvantage of increased oxygen (about 2-4 wt percent). Recently, the powder with grain size 10 μm or less whose oxygen level is in the neighborhood of 1-2 wt percent has been developed. By the reduction nitrification method, where the grain size basically depends on the raw material, fine powder can be obtained. On the other hand, unreacted carbon tends to remain, and its elimination process causes an oxidating AlN problem. Lately Kuramoto[9] developed an even grain size AlN powder of 1 μm or less which contains about 1 wt percent of oxygen. This powder was used to produce an AlN sintered translucent material whose total translucency is about 80 percent.

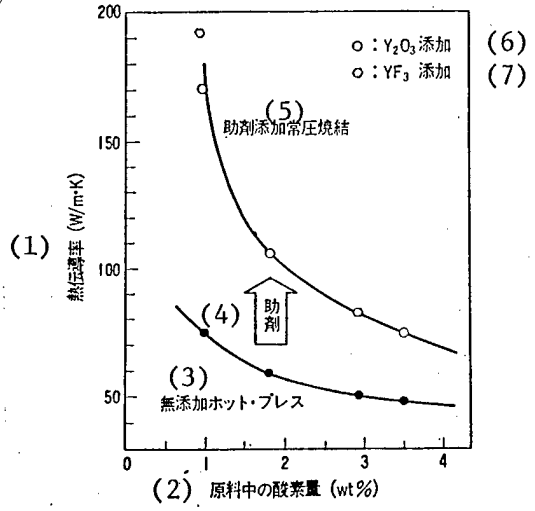


Figure 8. Relation between impurity oxygen amount in AlN raw material and thermal conductivity of its sintered material[17,18]

Key:
1. Thermal conductivity (W/m·K)
2. Oxygen amount in raw material (wt %)
3. Non-additive hot-press
4. Auxiliary agent
5. Normal pressure sintering with auxiliary
6. Y_2O_3 added
7. YF_3 added

Figure 8[17,20] shows changes in thermal conductivity around the room temperature when the AlN raw materials with different oxygen impurity levels are hot-pressed without additives or sintered under normal pressure (the optimal auxiliary level and the most suitable sintering conditions are used

for respective materials). It is known that in both the "hot-press without additive" process and the "normal pressure sintering with auxiliary" process, the thermal conductivity improves as the oxygen amount in the raw material reduces. Also, regardless of the oxygen levels the addition of the auxiliary served to improve the thermal conductivity from the level when the additive was not used. In particular the addition of the auxiliary is conspicuously effective with low-oxygen level materials.

The thermal conductivity of AlN is further improved by increasing the purity of the raw material and examining the auxiliary and sintering conditions. Details are not known but some published studies report recent achievements of thermal conductivity as high as 230-260 W/m·K[21,22].

4. Conclusion

This article discussed the factors controlling the thermal conductivity of ceramics and described the present situation of the AlN thermal conductivity improvement as it relates to raw materials and auxiliary agents. AlN is a "current" material whose development is ongoing in every aspect of raw materials, sintered materials, and application technologies. In this sense, it seems that characterization of AlN has not been done to the extent that warrants the coverage of this article which is entitled "Characterization Technology." Therefore the author hopes that the article is read as an introduction of themes to be characterized in the future.

FOOTNOTES

1. M. Ura, "Ceramic Substrate for Functional Circuit," Chapter 3, Electronic Material Industry Association, 1985, pp 41-55.

2. K. Shinozaki, A. Tsuge, "Ceramic Substrate for Functional Circuit," Chapter 4, Electronic Material Industry Association, 1985, pp 57-75.

3. G.A. Slack, GE Technical Information Series, No 84 CRD 126, June 1984.

4. A. Tsuge, et al., 1983 Ceramic Industry Association Annual Meeting Lecture Proceedings, D-35, 295, 1983.

5. For instance:
   (a) T. Nakamura, "Ceramics and Heart," Gihodo, 1985, pp 57-101.
   (b) T. Kawakubo, Applied Physics, 53, 278, 1984.
   (c) Y.S. Touloukian, "Thermal Conductivity Nonmetallic Solids," The TPRC Data Series Vol 2, 3a, Plenum, New York, 1970.

6. C.L. Julian, Phys. Rev., 137, 128, 1965.

7. G. Leibfried, et al., Nach. Akad. Wiss. Gottingen, Math. Phys. Klasse, 4, 71, 1954.

8. K. Shinozaki, et al., Kagaku to Kogyo (Chemistry and Industry), 37, 628, 1984.

9. W.D. Kingery, et al., J. Am. Ceram. Soc., 37, 107, 1954.

10. K. Shinozaki, et al., The 22nd Ceramics Industry Forum Lecture Summary Book, 3A, 12, 1984.

11. K. Yoneya, Chitsukyo (Ceramic Association), 89, 330, 1981.

12. A. Tsuge, K. Anzai, K. Shinozaki, T. Takahashi, A. Iwase, "Ceramic Data Book 1985," Industrial Product Technology Association, 1985, pp 396-400.

13. J.W. McCauley, et al., "Progress in Nitrogen Ceramics," NATO ASI Ser. E, Martinus Nijhoff Pub., Boston, 1983, pp 111-18.

14. G.A. Slack, J. Phys. Chem. Solids, 34, 321-35, 1973.

15. T. Sakai, et al., Chitsukyo, 86, 174, 1978.

16. N. Kuramoto, et al., Chitsukyo, 93, 517, 1985.

17. K. Shinozaki, et al., 1985 Chitsukyo Annual Meeting Proceedings, 3A60, 1985.

18. K. Shinozaki, et al., The 24th Ceramic Industry Forum Lecture Summary Book, ID 13, 1986.

19. N. Kuramoto, et al., J. Mater. Sci. Lett., 3, 471, 1984.

20. F. Ueno, The 24th Ceramics Industry Forum Lecture Summary Book, ID 14, 1986.

21. N. Kuramoto, et al., Proceedings of the 36th Electronic Components Conference (IEEE), 424, 1986.

22. Y. Kurokawa, et al., ibid., 412, 1986.

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DEVELOPMENTS IN PLASTICS, CERAMICS, METALS REPORTED

Tokyo NIKKO MATERIALS in Japanese Oct 86 pp 22-28

[Text] PLASTICS

Silicone Rubber Foam Which Can Be Molded Freely

Toshiba Silicone Co., Ltd. has developed a silicone rubber which foams in the shape of a sponge, and has started shipping samples by the brand name of "TSE5000."

The new foam polymer consists of a liquid in which hydrogen is put and vinyl base B liquid in which alkaline additives are put. When A and B liquids are mixed with each other at the same volume, chemical reactions such as the discharge of hydrogen and hardening occur and in 10 minutes this mixture is changed to a foam whose volume is about three times that of the mixture. The new foam polymer can be molded freely even at the working site, because it hardens at room temperatures.

The spongy foam is excellent in elasticity, has high strength, can withstand a temperature as high as 200°C. and is resistant to deterioration. For this reason it is used in gaskets which act as a buffer between metals, and it is suited to preventing parts from being lost by absorbing intensive vibration and impact.

Solid-Liquid Separation System Which Uses Special Filter Made of Polyester Woven Fabric

Toray Industries, Inc. has developed a system which can efficiently separate solid and liquid from each other without using flocculating agent or causing secondary environmental pollution, and has started full scale marketing of it.

This system consists of a continuous filtering concentrator called, "TS Filter" (brand name) and a continuous dehydrator called, "TM Press" (brand name). Both machines are equipped with a special filter made of a newly developed polyester woven fabric, and it is devised so that the special filter can filtrate stock solution. This special filter is produced by physical surface processing and weaving, and is constructed so that it can filtrate at its surface layer section, because its surface texture is closely woven.

It is so devised that the TS Filter filtrates and cleans stock solution under reduced pressure while rotating this special filter, and concentrates and recovers the solid contents. The features of this TS Filter are as follows: 1) particles with a diameter of 5 microns or more can be separated; and 2) it can be operated continuously for a month without any blinding of the special filter, because of its large capacity of 1,000^{m3} a day.

On the other hand, it is devised so that the TM Press filtrates stock solution under reduced pressure while rotating the special filter, the stock solution is dehydrated under pressure with a drum, solid contents are transferred to the drum, and the TM Press recovers the solid contents from the drum. The features of the TM Press are as follows: 1) compared with conventional dehydrators, the processing cost can be reduced by 30 percent, because of no use of flocculating agent; 2) no auxiliary facility is required in the TM Press, because of no use of flocculating agents; and 3) it is useful to recover valuables, because no agents are mixed in.

Inorganic Man-Made Lumber With Humidity Controll Function Used in Interiors of Art Museums and Skyscrapers

Ohbayashi Corp. has developed a man-made lumber possessing a humidity control function, and has started manufacturing and putting it on the market through its affiliate, Naigai Lumber Industry Co., Ltd. This man-made lumber can absorb and discharge moisture contained in air in the same way as lumber.

This new material is molded in accordance with the following procedures. Of the calcium silicates used generally as a noncombustible building material, zonotrite which has little change in weight and is stable, even when heated, is dissolved in water. The high-molecular compound and glass fiber are added to give strength to this mixture. Next, water is squeezed out of the mixture under pressure of 2.5 atmospheres by using a special filter. The ratio of components is 89 percent zonotrite, 6 percent high-molecular compound, and 5 percent glass fiber. The mixture is dried with a standard moisture content of around 2 percent.

The specific gravity of this man-made lumber is 0.50, between 0.38 for cryptomeria and 0.69 for zelkova, that is, almost the same as general lumber. Nails and screws can be driven into the man-made lumber, and it does not rot or burn.

Also, when the new material was put in a testing machine in which the temperature was kept at 20°C. and the humidity was changed from 50 to 90 percent and from 90 to 50 percent to investigate its humidity control function, it was confirmed that the change in the state of the new material was less than in lumber, and that it absorbed and discharged moisture content.

The price is ¥200,000 to ¥220,000 per cubic meter, which is equivalent to that of high-class lauan. It is expected that the new material will be used as an interior material for Japanese-style rooms in skyscrapers and as a structural material for storehouses of art museums.

Injection-Moldable PET Resin Is Used to Package Electronic Parts

Unitika, Ltd. has developed a special PET (polyethylene terephthalate) resin which can be injection-molded under low pressure, and has started shipping samples. The PET resin is used to package electronic parts.

The fluidity of the newly developed resin has been enhanced sharply while changing the chemical composition and molecular weight, improving the performance of the PET itself, and maintaining the basic physical properties of polyester resin, which is a typical thermoplastic resin, by adding a special plasticizer and a special polymer to the PET which consists of terephthalic acid and ethylene glycol.

When the existing PET resin is injection-molded, it requires a high pressure of 800 kg/cm^2, but the new PET resin requires only a pressure of 150 kg/cm^2 or less. In addition, the heat resistance is high, and the heat distortion temperature is 185° to 210°C, equivalent to that of epoxy resin (200°C.).

The epoxy resin which presently accounts for 90 percent of the resin packaging of electronic parts is not suitable for injection-molding, because of thermosetting. Therefore, after it is molded, reaction must be generated on it at a temperature of 170° to 180°C. for 3 to 10 hours. In contrast, it is possible to injection-mold the new resin under low pressure and to omit the reaction process after molding work, because the new resin has the fluidity to be extruded 42 to 58 centimeters with a pressure of 125 kg/cm^2. Also, unlike the epoxy resin, it is neither necessary periodically to clean the mold dies nor to preserve the new resin at a low temperature.

Compact, Low Cost, Lightweight Plastic Acceleration Sensor Appears

Mitsubishi Oil Co., Ltd. has developed an all-plastic acceleration sensor and has started selling it under the brand name of "Super-G."

The acceleration sensor is used to measure such movements as the vibration and shake of objects. Up to now, the piezoelectric type acceleration sensor costing ¥50,000 to ¥200,000, and the more expensive strain gage type acceleration sensor, and servo type acceleration sensor have been used in high accuracy areas.

The Super-G is a compact and lightweight sensor which uses, as a vibrator, piezoelectric plastic (a composite material of polyacetal and lead titanate zirconate powder) which when bent or strained, generates electricity, and inversely, when electricity is passed through it, bends or vibrates. The Super-G was developed for use as a control mechanism and sensor which transmits information when directly incorporated in automobiles, robots, and rotating tools and on vibration or shake machines. The price has been held down to ¥4,800.

The main features of the Super-G are: 1) it is excellent in impact resistance, and easy to handle; 2) it can measure low frequencies up to 0.5 to 500 hertz; 3) it is very sensitive to single axis vibration; and 4) installation is simple because it is compact, lightweight, and thin.

Ultraviolet Hardening Type Fluorocarbon Resin Enhances Optical Fiber Function

Dainippon Ink & Chemicals, Inc. has developed an ultraviolet hardening type low refraction index fluorocarbon resin, and has started selling it under the brand name of "Defenser Series."

Mainly, the fluorocarbon resin is the solid melt molding type, but the new resin is the liquid coating type. The new resin is applied to the surface of base materials, and is hardened by irradiation by ultraviolet rays for 1 to 2 seconds. It is characterized by the wide range of viscosity in the application (1,000 to 5,000 cP) and the low refraction index of 1.38.

At present, the resin based on thermosetting type silicon is mainly used in optical fiber cladding materials. The refraction index of this resin is 1.40 to 1.41, higher than that of the fluorocarbon resin. In order to enhance the optical fiber function, it would be better to have a large difference between the refraction index of the core and that of the cladding materials. For this reason, the refraction index of these cladding materials can be lowered by using fluorocarbon resin, but up to now, there has been no fluorocarbin resin which can be applied to the surface of base materials.

The transmission loss of silicon is 10 decibels at a wavelength of 0.85 micrometer, while that of the new resin is reduced by half to 5 to 6 decibels, and it can greatly enhance performance. The production speed (170 to 300 meters per minute) is increased to 8 to 15 times.

The company will increase the range of applications of this new resin as a surface protecting material, mainly as an optical fiber cladding material.

First Earthquake Isolation and Vibration Proof Building Lowers the Vibration Caused by Earthquakes to One-fourth

Kajima Corp. has completed an earthquake isolation and vibration proof building in Kajima Institute of Construction Technology located in Chofu-city, Tokyo. This building was constructed as an experimental laboratory to perform experiments on acoustic and environmental vibrations. It is a two-story reinforced concrete structure with a total floor space of 636 square meters.

At present, a technology to suppress vibrations caused by earthquakes and busy streets is keenly desired for high-technology industrial facilities such as super-accurate processing plants and for high-quality buildings such as hotels and hospitals.

Therefore, the company has developed an earthquake isolation and vibration proofing method whereby insulating materials are put between a building and the ground and these insulating materials absorb vibration in order to suppress it. This method is used in the experimental laboratory just completed.

The laminated rubber bearing, a damping unit (elastroplastic damper), and a rocking controller (buffer) are used in this method. Particularly, flexible rubber in the vertical as well as horizontal directions is used in the laminated rubber bearing made by alternately layers of rubber plates and steel plates. This laminated rubber bearing has achieved the reduction (earthquake isolation) in seismic force and the cutting-off (vibration proof) of minor vibrations caused by busy streets.

The company is sure that the use of this new method will lower the degree of vibration caused by earthquakes to one-fourth and that of the usual minor vibrations to about one-tenth. In the future, the company will perform practical experiments in the experimental building, and will verify the effectiveness of the new method.

CERAMICS

Ultrasonic Spindle System Processes Fine Ceramics With High Accuracy

Ultrasonic Engineering Co., Ltd. has developed an NC (munerical control) machine tool called, "Ultrasonic Spindle System, USP-201" which can process fine ceramics with high accuracy, and has started putting it on the market.

It is so devised that this machine tool can process fine ceramics by imparting micro-vibrations caused by ultrasonic waves in the longitudinal direction to a diamond-bonded grinding wheel rotating at high speed. Compared with conventional machine tools using only the rotation of a diamond-bonded grinding wheel, this new machine tool can drill, punch, and groove hard and brittle materials such as fine ceramics, and glass with high accuracy within a short time, because the new machine tool makes the best of a composite effect of rotation and vibration. Also, the machined surface of these materials is smooth, and there is little cracking and notching in the materials.

In addition to the above matters, the new machine tool possesses the following features: 1) when large torque is applied unexpectedly to the diamond-bonded grinding wheel during processing work, the new machine tool will stop the forced notching feed and will prevent damage to the tool; 2) the processing time can be shortened and the optimum processing conditions can be set by inputting the feeding speed per hour in the new machine tool; and 3) the processing results can be obtained readily because the cutting depth is indicated digitally.

The new machine tool consists of the ultrasonic spindle, the main body, and the NC unit. The price is ¥15.5 million.

High-Purity cBN Thin Film May Realize Low-Price Carbide Tools

ULVAC Corp. has succeeded in synthesizing a thin film of high-purity cubic boron nitride (cBN).

The cBN is a new material which stands second after the diamond in thermal conductivity and hardness. The life of carbide tools employing such cBN is tens of times longer than that of tools coated with a titanium carbide film, but high temperature (1,500 degrees centigrade) and high atmospheric pressure (50,000 millibars) are required to synthesize sintered objects. For this reason, the price of these carbide tools is 10 times higher than that of tools made of titanium carbide.

Therefore, cBN thin films have been synthesized by using the reaction of gas, but up to now only cBN film containing hexagonal boron nitride (hBN) with different crystal forms has been synthesized.

The company has succeeded in manufacturing a thin film by activating nitrogen gas which is a raw material for cBN through the use of electron beams and by applying high frequency voltage to a wiring board which will be the basis for the thin films. A high-purity thin film which does not contain any hBN has been manufactured by controlling the intensity of high frequency voltage applied to this wiring board and of the current flowing to a nitrogen gas injection nozzle.

The thickness of this thin film is about 0.3 micron. To coat carbide tools this high purity thin film, must have a thickness of at least 2 or 3 microns. In the future, the company will narrow the research to reduction in internal stress, and will put the results to practical use.

Pulverization By Ultrasonic Waves, Technology for Fine Ceramics Is Introduced From an U.S. Company

Mitsui Miike Engineering Corp. has introduced from EMR Corp. in the United States a technology to manufacture pulverizers employing the vibration of ultrasonic waves. In the future, Mitsui Miike Engineering Corp. will further enhance the pulverizing accuracy, will develop the pulverizer as equipment for fine ceramics on the basis of this technology, and will put it on the market.

The pulverizer is so constructed that a vibrator comes into contact with a roller, and materials to be pulverized are put in through an opening at the upper portion and are pulverized by the contact section between a roller and the lower portion of the vibrator. The roller turns at tens of revolutions per minute, and the vibrator vibrates at 16,000 to 20,000 hertz. The pulverizer was originally developed to grind coal finely, and the size of pulverizer material is 40 to 50 microns.

Up to now, the ball mill method has been used generally to pulverize materials, but pulverizers using the method developed by EMR Corp. require only about 20 to 30 percent of the power needed by the ball mill method. Also, it is said that evenly pulverized products can be obtained within a short time.

Mitsui Miike Engineering Corp. is planning to apply this technology to pulverizing, to develop a pulverizer which can finely grind materials to the size of 1.3 to 3 microns, and to commercialize it within this year.

Cottony Hydroxyapatite Is Optimum as Artificial Bone

Toa Nenryo Kogyo K.K. has developed a fibrous hydroxyapatite (main component of bones) for bio-ceramics, and will commercialize it in an early period with consideration to the results obtained from clinical tests. This fibrous hydroxyapatite is excellent in workability, and can be handled readily.

Hydroxyapatite has various uses in the root of teeth or auditory ossicles, because it is harmless and adapted for human bodies as an artificial bone to replace bone damaged by accident or disease. However, an existing product is deficient in handling characteristics during an operation and has limited scope because it is powdery, granular, and porous.

The company has developed fibrous hydroxyapatite by converting the existing product into fiber. As a result, this new product can be used in bones even if they are damaged seriously, and the postoperative stability is good. In addition, it is said that the new product is harmless and adapted for human bodies and will be integrated with the bone within 2 weeks after an operation. The price is ¥3,000 to ¥5,000 per gram, about equal to the existing product.

Surface Area of Porous Silicon Carbide Is More Than 10 Times That of Conventional Silicon Carbide

The National Chemical Laboratory for Industry of the Agency of Industrial Science and Technology of MITI (Ministry of International Trade and Industry) and Ibiden Co., Ltd. have jointly developed a porous silicon carbide ceramic having innumerable minute holes with a diameter of 10 to 20 microns and having a surface of 15 to 20 m^2/g.

Silicon carbide is a structural ceramic material excellent in resistance to wear, oxidation, and corrosion. When it is used as a structural ceramic, generally, it will be sintered as minutely as possible, because the smaller the number of holes, the higher such characteristics as strength and impact become. The Chemical Engineering Laboratory and Ibiden Co., Ltd. have reversed this idea, and have developed a porous ceramic having an average compressive strength of 300 kg/cm^2 which is equivalent to that of brick, and having a surface area per gram of 1 or 2 m^2 which is more than 10 times that of conventional structural ceramics.

The most important feature of porous materials employing silicon carbide is the very good thermal conductivity. When such a porous material is used as a catalyst for oxidative reaction in the petrochemical field, it will efficiently discharge heat generated during oxidative reaction out of the reaction system and will enhance the selectivity of reaction. Also, when it is coated with submicron order alumina, its surface area is expanded and its application to heat resistant catalyst carriers can be expected.

Sintered Diamond With a Purity of 97 Percent Is Manufactured

Toshiba Tungaloy Co., Ltd. has, on consignment from the RDCJ (Research Development Corporation of Japan), developed a technology for manufacturing high-purity sintered diamond with the aim of putting it to practical use.

At present, diamond sintered by putting diamond powder on the surface of alloys such as cemented carbide, is used to cut unworkable materials such as new ceramics and FRM (fiber-reinforced metal). However, the diamond sintered by using this method has the disadvantage that solvents remain in the sintered diamond and neither sufficient hardness nor toughness can be obtained because a large amount of metallic solvents such as cobalt and nickel, are used to sinter the diamond.

The recently developed technology will change to graphite a part of the surface of the diamond powder which is the raw material, will make sintering easier, and will reduce the amount of solvents used. Originally, the highest atmospheric pressure and the highest temperature of a high temperature and high pressure generating unit were 60,000 millibars and 1,500 degrees centigrade, but the company has achieved the ultrahigh pressure of 65,000 millibars and the ultra-high temperature of 1,500 degrees centigrade, and has succeeded in manufacturing the sintered diamond with a purity of 97 percent by changing the structure of the anvil which transmits pressure to the diamond to be sintered, and by doubling the gasket structure which restrains pressure.

METALS

Ultralow Void Oxygen-Free Copper Is Mass-Produced, and Exercises Its Power in Enlarging Electron Tubes

Hitachi Cable, Ltd. has succeeded in mass-producing an ultralow void oxygen-free copper containing gas whose amount is minimized.

This oxygen-free copper is a high quality product which has cleared Class 1, the highest level of oxygen-free copper stipulated by the ASTM (American Society of Testing Materials). The company has independently developed a special gas removing unit, and has achieved a sharp reduction in the amount of gas contained in copper by limiting the generation of gas voids within the copper, using this unit in a continuous melting and casting facility which employs a gas deoxidizing system.

The oxygen-free copper ranked Class 1 has a purity of 99.99 percent or more, and observation by an electron microscope indicates that compared with copper ranked in Class 2 and 3, it has an extremely small amount of metallographic contamination after it is heated at a temperature of 850°C for 30 minutes in a hydrogen atmosphere. It is thought that the amount of metallographic contamination depends on the amount of gas contained in the copper, and the smaller the metallographic contamination, the higher the reliability in the maintenance of the high degree of vacuum, and the prevention of internal contamination caused by gas-bleedoff.

The commercialization of this Class 1 oxygen-free copper has enabled the company to produce large electron tubes which have better vacuum characteristics, and is expected to increase the range of applications of copper for high technology products, mainly in the manufacture of semiconductors.

Chemical Heat Pump Employing Metallic Alloys for Hydrogen Storage and Single-Body Can Output 3 Million Kilocalories

Chiyoda Chemical Engineering & Construction Co., Ltd. and Japan Steel Works, Ltd. have succeeded in putting to practical use a chemical heat pump employing metallic alloys for hydrogen storage. The output of this pump per hour is 300,000 to 3 million kilocalories (k cal).

This system is a single-body type pump in which two kinds of metallic alloys for hydrogen storage are stored 1.8 tons at a time, 3.6 tons in total, in a heat exchanger partitioned with a specially processed steel plate. These metallic alloys contain different amounts of calcium and nickel. The combination of two systems will bring about a continuous rated output of 300,000 k cal/hr. The cost of manufacturing conventional heat pumps employing metallic alloys for hydrogen storage is high, because these heat pumps are of double-body type and the plate used to partition the heat exchanger is made of nickel. The new system is compact and inexpensive, because it is the single-body type. The output of conventional heat pumps is 10,000 k cal/hr at most, but it is said to be possible to increase the output of the new heat pump to 300,000 to 3 million k cal/hr.

When this new system is operated to raise the temperature of hot water, the temperature can be increased from 65 to 80-85°C, and inversely, when operated to lower the temperature of exhaust hot water, the temperature can be decreased from 25 to 5°C.

Japan Institute of Light Metals Establishes Composite Material Subcommittee

The JILM (Japan Institute of Light Metals) held a board of directors meeting and decided to establish a new subcommittee, "Composite Material Subcommittee." Takashi Nishimura, a professor of the Faculty of Engineering, Tokyo Metropolitan University was appointed as the first chairman of the subcommittee.

In 1977 the JILM established a research committee to promote research on the aluminum industry. Up to now, the JILM has established six subcommittees, i.e., the casting and hardening, metal processing, metal molding, surface technology, material and physical properties, and smelting subcommittees. The companies and universities affiliated with the JILM jointly conduct research which transcends the area of any particular enterprise.

Recently the degree of interest in light metals and composite materials has increased, so the JILM has established this new subcommittee.

First the Composite Material Subcommittee will set about two subjects: 1) the interface reaction and wettability between fiber and matrix, and 2) non-destructive inspection. In the future, the new subcommittee will urge such

relevant worlds as aircraft, automobile and fiber manufacturers to join the new subcommittee, and will develop the research to promote and industrialize the products.

Toward Development of a Laser CVD. Thin Film Formed on Wafers at Low Temperature

IHI (Ishikawajima-Harima Heavy Industries, Co., Ltd.) has started developing a laser CVD (chemical vapor deposition) whereby a thin film is formed on the surface of silicon wafers irradiating laser light.

In the semiconductor manufacturing process, the insulating film and protective film are formed by coagulating a gaseous evaporating substance on the surface of wafers. The PVD (physical vapor deposition) and the plasma CVD are most frequently used as methods of forming these thin films. The former is a sputtering deposition whereby thin films are formed by accelerated ions striking against an evaporating substance and by gasifying these ions, and the latter is a method whereby a reaction is caused by plasmolyzing raw material gas.

In contrast, the company is hurrying to commercialize a laser CVD method whereby thin films are formed by irradiating laser beams causing a chemical reaction on the surface of wafers.

Laser beams are used in high-output wavelength variable laser equipment, developed by the company in 1983, which can cover the area from infrared rays to ultraviolet rays with wavelengths of 4 to 0.1966 microns.

As a result of conducting experiments up to now, the following results have been obtained because no high-temperature is required to form thin films and thin films can be formed within a short time: 1) strain is not readily generated from wafers; 2) defects caused by charged particles do not occur in wafers; and 3) impurities do not readily mix with wafers. Therefore, the company has considered that the use of this new method will enhance the yield more than ever and will permit coping with large diameter wafers.

Increase in Wear Resistance

Development of Pearl Color Developing Technology

Showa Aluminum K.K. has succeeded in developing a pearl color developing technology, has a tie-up with a surface treatment manufacturer of the brand name of "Showa Color AP," and has started receiving order for products. Up to now, it has been impossible to develop pearl color from aluminum alloy by using an anodization coloring method.

Showa Aluminum K.K. will offer color developing materials to the surface treatment manufacturer. The surface treatment manufacturer will introduce a treating facility with a capacity of about 1 million products per month, will receive orders for color developing work for office supplies and precision equipment, and will carry out the work.

Up to now, the self-color anodizing process based on sulfonic acid or sulfuric acid has popularly been used as a color developing method by electrolyte, but it is difficult to develop pearl color by this method.

The technology currently developed by the Showa Aluminum K.K. is an anodizing process using oxalic acid electrolyte. This is an electrical recovery technology whereby a very small amount of copper is added to aluminum alloy materials. After these materials are anodized in an oxalic acid electrolytic bath, voltage is sharply lowered, and when the voltage is kept at a low level, the current value temporarily is zero, and subsequently, the stationary current value corresponding to the low voltage is obtained.

The features of this technology are as follows: 1) the thickness of films can be selected in accordance with durability, and are excellent in wear resistance; 2) the color tone can be changed by changes in electrolytic conditions, and 3) the coloring uniformity is good, and it is possible to handle products with complex shapes.

Manufacturing of High-Quality FRM New Aluminum Forging Technology

Sumitomo Light Metal Industries, Ltd. has developed a liquid metal forging technology which can be used to manufacture readily composite products such as aluminum and various whiskers, fibrous materials and composite reinforced materials (FRM: fiber reinforce metal), and other metals and combined products.

The liquid metal forging technology is a method to produce high quality products by removing casting defects from the liquid metal of aluminum alloys by applying high-pressure to the liquid metal in the process which solidifies the liquid metal.

It has become possible to manufacture high-quality products and to compound dissimilar metals by using a new forging method developed by adding an unique technology to the above manufacturing method. Specifically, it is possible to enhance the mechanical characteristics and the improve remarkably the weld-ability by carrying out the heat treatment, because products having a fine solidification structure can be obtained with neither shrinkage cavities nor pores. It is also possible to compound various fibrous materials and to forge dissimilar metals with each other, because the pressurization will enhance the permeability and adhesive properties.

Particularly, aluminum can be permeated even in very narrow spaces of fibers by applying high-pressure to FRM, and it is also said that the only necessary portions need be changed to FRM.

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